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Yes, I would like the following:

☐ A demonstration of the Model _____

☐ Technical details about the Model _____

☐ I have the following special requirement: _____

_____

_____

_____

No, I do not have a use for your equipment at the present time because,

_____

_____

INSTRUCTION MANUAL
MODEL 737

30MHZ LOG SWEEP
FUNCTION GENERATOR

® Box 347 Tillamook OR 97141
Telephone 503-842-8441
TWX 510-590-0918
EXACT electronics, inc.

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IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper setup.

2. Check fuse and power supply voltages.

3. Call your Exact representative or factory. Instruments returned to the factory will be accepted only if they are sent freight prepaid, unless Exact or factory representative has authorized otherwise.

CLAIM FOR DAMAGED SHIPMENT

The instrument should be inspected as soon as received. If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy sent to Exact. After receiving this report, Exact will advise you of the dispostion of the instrument and arrange for its repair or replacement.

WARRANTY

Exact warrants its instruments to be free from defects in material and workmanship under normal use for a period of twelve months from the original date of shipment. Exact's obligation is limited to repair or replacement.

All repairs and replacements made under this warranty are f.o.b. Exact's factory or designated service depot unless otherwise authorized by Exact. This warranty is made on condition that prompt notice of defect is given to Exact, in writing, within the warranty period and that Exact shall have the sole right to determine whether in fact a defect exists.

This warranty does not apply to any instrument which has been repaired or altered by other than Exact's own service representative so as, in Exact's judgment, to adversely affect it, nor which has been subject to misuse, negligence or accident or which has been operated contrary to sound practice or operating instructions.

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SECTION 1

SPECIFICATIONS

AND

VERIFICATION OF SPECIFICATIONS PROCEDURE

WAVEFORMS
Sine, triangle, square, pulse, ramp, and step.

OPERATING MODES
Main Generator: Run, gate, trigger, linear sweep, log sweep, burst, pulse, linear frequency step, log frequency step.
Ramp/Step Generator: Run, gate, trigger, hold.

FREQUENCY RANGE
Main Generator: 0.0001 Hz to 30 MHz.
Ramp/Step Generator: 1μ sec to 1000 sec.

FREQUENCY ACCURACY
± (1% of setting plus 1% of full scale) 0.01 Hz to 1 MHz.
± (2% of setting plus 2% of full scale) 0.0001 Hz to 0.01 Hz and 1 MHz to 10 MHz (1 MHz range position).
± 5% of full scale (3 MHz range position).

FREQUENCY STABILITY
0.05% of setting for 10 minutes.
0.25% of setting for 24 hours.

MAIN OUTPUT
50 Ohms output impedance.
30 V P-P open circuit.
15 V P-P into 50 Ohms.

AMPLITUDE STABILITY
0.05% of max. P-P amplitude for 10 minutes.
0.25% of max. P-P amplitude for 24 hours.

ATTENUATOR
60 dB in 10 dB steps plus 20 dB variable.

SINEWAVE FREQUENCY RESPONSE
< 0.1 dB to 100 KHz.
< 2 dB to 30 MHz.

SINEWAVE DISTORTION
< 0.5% 0.0001 Hz to 100 KHz.
No harmonics < 30 dB down 100 KHz to 30 MHz.

SQUAREWAVE
Rise and Fall $\leq$ 10 nsec.
Aberrations < 5%.

SYMMETRY (time)
Within ± (1% plus 2 nsec).
Variable symmetry range: 1:19 to 19:1 (frequency is divided by approximately 10).

TRIANGLE NONLINEARITY
Within 1% of best straight line to 100KHz.

MAIN GENERATOR GATE AND TRIGGER MODES
DC coupled.
Input impedance: Approximately 1K.
Signal requirements: +200 mV or manual for turn on.
Variable to +15V.
Start phase adjustable over ± 90° range.

RAMP/STEP GENERATOR GATE AND TRIGGER MODES
TTL compatible, or manual.
5 K input impedance.

VCF INPUT
0 to 5 V input for 1000:1 frequency control.

DC OFFSET
Switchable and variable.
± 7.5 V into open circuit.
± 3.75 V into 50 Ohms.
Not affected by attenuator settings.

V:f OUTPUTS (Voltage proportional to frequency)
Approximately +5 mV to +5V for 1000:1 frequency range.

SYNC OUTPUT
A switch selects either Main Sync or Ramp Sync.
TTL compatible squarewave.
Approximately +3 V peak.

RAMP/STEP OUTPUT
Approximately +2 V peak open circuit.
600 Ohms output impedance.
Approximately +0.2 V per step open circuit.

POWER REQUIREMENTS

Input voltage: 115 VAC ± 10% or 220 VAC ± 10%.

PHYSICAL CHARACTERISTICS

Case dimensions: 43 cm wide by 13 cm high by 34.8 cm deep.
Overall dimensions: 43 cm wide by 14.5 cm high by 39 cm deep.
Top and bottom covers are easily removable, exposing all calibration and circuit board areas.

NOTE

Unless otherwise specified, specifications apply from 10% to maximum output voltage terminated into 50 Ohms and do not apply at frequency multiplier settings less than 1.0. Specifications are valid at 25° C ± 5° C after a 30 minute warmup and with specified line voltage applied.

Specifications subject to change without notice.

It is recommended that the instrument be operated with covers in place for a period of 1 hr. before verification of specifications.

The following test equipment or suitable equivalents of known accuracy are required for complete specification validation for the Model 737 SWEEP FUNCTION GENERATOR.

Oscilloscope, DC to 100MHz
Differential Input with 5mV/cm sensitivity
Tektronix 7704 with 7A13 Plug-in or equivalent
Counter-Timer, 30 MHz to 10,000 seconds
Racal-Dana 8010B or equivalent
DVM, 0.01% accuracy with 1,000 meg ohm floating input
Racal-Dana 4600 or equivalent
Harmonic Distortion Analyzer, less than .1% residual distortion
H-P 333A or equivalent
Spectrum Analyzer, 1KHz to 110MHz
Hewlett-Packard 141T, 8553B, 8552B or equivalent

Preset all the front panel controls as follows:

START FREQUENCY
RANGE - HZ - 100
FUNCTION - square
AMPLITUDE - CW
D.C. OFFSET - OFF
ATTENUATOR - OFF
RUN - IN
START LEVEL - mid range
SWEEP - OUT
VAR SYM - OUT
TRIGGER LEVEL - mid range
RAMP/STEP - OUT
SINGLE - IN
GATE - OUT
HOLD - OUT
RAMP/STEP TIME - 1mS
MULTIPLIER - 1.0

FREQUENCY ACCURACY: To measure the frequency accurately all frequency measurements below 1 kilohertz are expressed in time and all above in freq. With the counter connected to main output: terminated in 50Ω, measure the following:

Mult.	HZ/SEC	Actual Setting	Accuracy	Generator should be within
10.0 X	.001	.01Hz	±(2% of setting + 2% of Range)	104 Sec. to 96 Sec.
1.0 X	.001	.001Hz	"	1282 " to 820 "
10.0 X	.01	.1Hz	±(1% of setting + 1% of Range)	10.2 " to 8.8 "
1.0 X	.01	.01Hz	"	112 " to 90 "
10.0 X	.1	1.0Hz	"	1.01 " to .99
1.0 X	.1	.10Hz	"	11.2 " to 9.00"
10.0 X	1	10Hz	"	.102 " to .098"
1.0 X	1	1.0Hz	"	1.11 " to .890"
10.0 X	10	100Hz	"	10.2 ms to 9.80 ms
1.0 X	10	10Hz	"	112 ms to 90.0 ms
10.0 X	100	1KHz	"	1.02 ms to .980 ms
1.0 X	100	100Hz	"	11.2 ms to 9.00 ms
10.0 X	1K	10KHz	"	9.80 KHz to 10.2 KHz
1.0 X	1K	1KHz	"	.890 KHz to 1.11 KHz
10.0 X	10K	100KHz	"	98.0 KHz to 102 KHz
1.0 X	10K	10KHz	"	8.90 KHz to 11.1 KHz
10.0 X	100K	1.0MHz	"	.980 MHz to 1.02 MHz
1.0 X	100K	100KHz	"	89.0 KHz to 111 KHz
10.0 X	1M	10MHz	±(2% of Range + 2% of setting)	9.60 MHz to 10.4 MHz
1.0 X	1M	1MHz	"	.780 MHz to 1.22 MHz
10.0 X	.30M	30MHz	±(5% of Range)	28.5 MHz to 31.5 MHz
1.0 X	.30M	3MHz	"	1.5 MHz to 4.5 MHz

SINE DISTORTION: Return the Function Selector to Sine Wave and also check to see that generator frequency is set for 1 kilohertz. Amplitude Control should be set CW.

1. Connect Distortion Analyzer to the Output Connector terminated into 50Ω. Measure the sine distortion of less than .5%. (typically .3%).

2. Set the START FREQUENCY to 100KHz. Measure Sine distortion of less than .5%.

3. Set Range to 1MHz. Connect the Spectrum Analyzer to main OUTPUT jack and measure the harmonic content. Observe no harmonics less than 30 db down from fundamental.

4. Check Harmonic Content on 10MHz and 30MHz Range. Observe no harmonics less than 30 db down from fundamental.

SINE FREQUENCY RESPONSE: Set the RANGE-HZ to 1K and START FREQUENCY to 10.0 and connect the oscilloscope to the OUTPUT connector. 50 ohm terminator must be connected to coax on the oscilloscope end.

1. Observe sine wave amplitude.

2. Set RANGE-HZ to 10K. Observe sine amplitude change of less than 0.1 dB.

3. Set RANGE-HZ to 3 MHz. Observe sine amplitude change less than 2db.

SQUARE WAVEFORM: Set FUNCTION to Square. Set AMPLITUDE for an output voltage of 15V peak to peak into 50 Ω.

1. Observe the rise and fall time to be less than or equal to 10 ns.

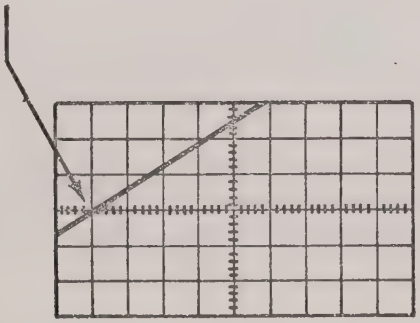
2. Observe that the overshoot and ringing are less than 5% of maximum peak to peak amplitude.

TRIANGLE LINEARITY: Set RANGE-HZ to 100, Start Frequency to 10. Set the FUNCTION to Triangle. Monitor the Output Connector with the oscilloscope.

1. Adjust the oscilloscope to obtain 1/2 cycle of the triangular waveform across the full horizontal grid on the oscilloscope CRT.

2. Reset the Differential Plug-in to a sensitivity of 20 millivolts per centimeter.

3. Adjust the comparison voltage until the slope of the triangle waveform intersects the mid-scale horizontal grid line at the second major mark as shown below.



TRIANGLE LINEARITY: (Continued)

4. Record reference voltage using the DVM accurate to 1 millivolt.

5. Adjust the comparison voltage until slope of triangle intersects next major horizontal grid mark.

6. Record accurately the new reference voltage.

7. Repeat to obtain as many points as desired.

8. Calculate linearity and observe linearity is within specifications.

9. Beware of oscilloscope inadequacies above 10KHz.

FREQUENCY STABILITY: Connect Frequency Counter to main OUTPUT terminated into 50Ω. Measure frequency accurately. Note the frequency reading. Wait 10 minutes. Measure frequency again and note that frequency change should be less than .05%. Wait 24 hrs. Measure frequency again and note reading remains within .25%.

AMPLITUDE STABILITY: Set AMPLITUDE to maximum. Set DC OFFSET to Off. FUNCTION to Triangle. Connect OUTPUT of generator to oscilloscope and measure the output, both positive and negative peaks with a 20 millivolt per centimeter sensitivity on the oscilloscope. Measure accurately and record the value of the positive and negative peaks that the triangle produced at the output. Wait 10 minutes and measure positive and negative peaks again and observe the amplitude changes less than 15 millivolts. Wait 24 hrs., measure the positive and negative peaks again and observe the amplitude change is less than 75 millivolts. Note that when measuring the amplitude using the peaks the maximum peak to peak value is the addition of the two peak values. On these expanded ranges the oscilloscope becomes temperature sensitive, beware of drift.

TIME SYMMETRY: Connect the counter timer to the SYNC OUT Connector on the front panel. Set the RANGE-HZ to 1K and set the START FREQUENCY to 10. Set the Counter Timer to read time interval A to B and B to A. Observe the time symmetry error is less than 1%.

1. Set RANGE-HZ switch to 100. Observe time symmetry error less than 1%.

2. Set RANGE-HZ to 10. Observe time symmetry error less than 1%.

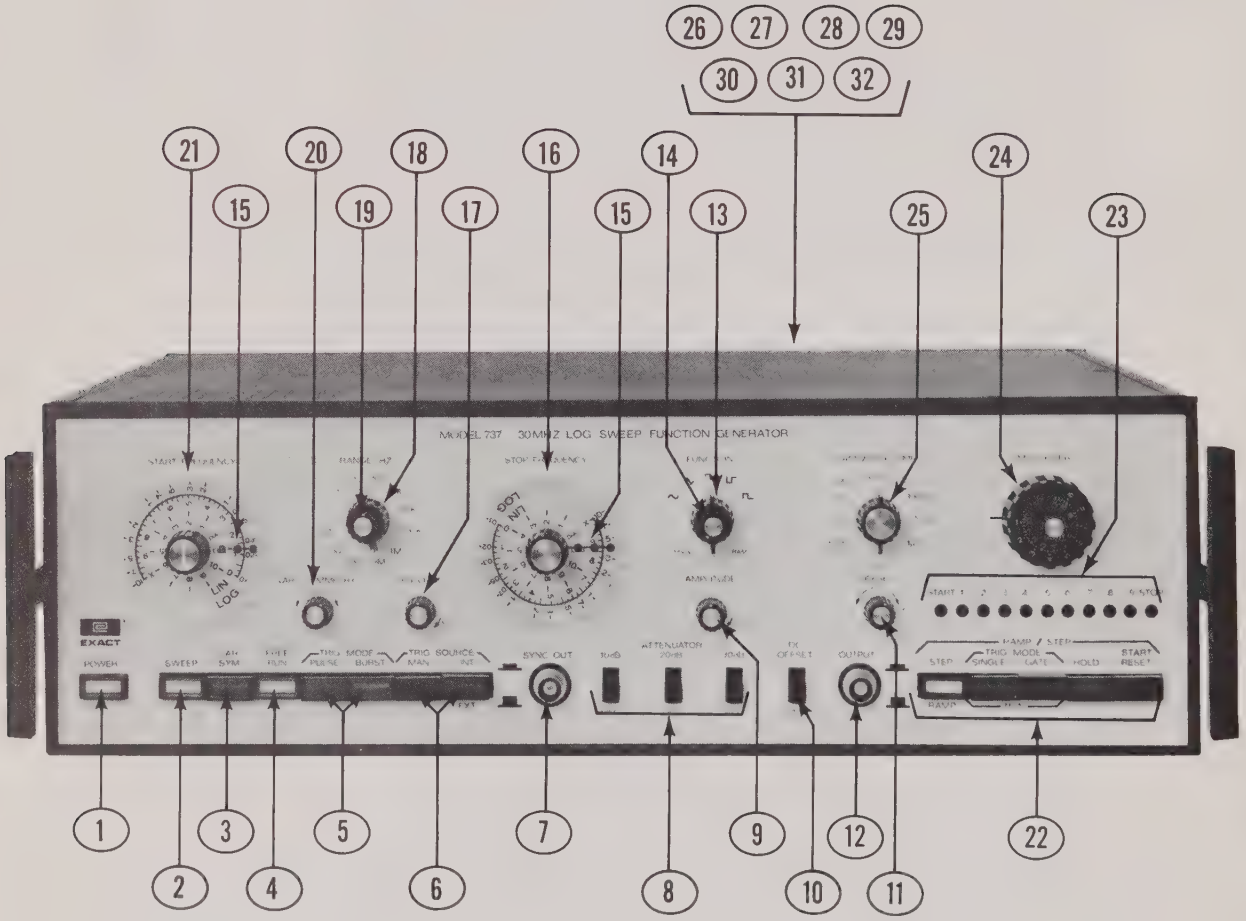
3. Set RANGE-HZ to 1. Observe time symmetry error less than 1%.

4. Set RANGE-HZ to 0.1. Observe time symmetry error less than 1%.

5. RAMP TIME: Switch the SYNC control to Ramp, observe Ramp time of 1mS.

SECTION 2

OPERATING INSTRUCTIONS



FRONT PANEL FAMILIARITY
MODEL 737

FRONT AND REAR PANEL FAMILIARITY

1. POWER SWITCH - Applies power to generator.

2. SWEEP - This control, when activated, allows the Ramp generator to vary the frequency of the Main generator at the rate selected by the RAMP/STEP TIME and MULTIPLIER switches.

3. VAR SYM - Enables VAR SYMMETRY control (20) and divides Main generator frequency by approximately 10.

4. FREE RUN - Causes Main generator to free run.

5. TRIG MODE - Two pushbuttons select PULSE (triggered) or BURST (gated) modes.

   a. In the PULSE mode, one complete cycle is produced for each trigger command.

   b. In the BURST mode, cycles are produced until the trigger command is removed. The last cycle is completed.

6. TRIG SOURCE - Two pushbuttons select INTernal, EXTernal or MANual triggering. When INT is selected, the Ramp generator will trigger the Main generator into operation at a rate set by the RAMP/STEP TIME and MULTIPLIER switches. EXT selects the BNC on the rear panel as trigger source or MAN pushbutton may be used as the source in this mode. Note: PULSE or BURST must be selected for TRIG SOURCE to function (5).

7. SYNC OUT - BNC connector provides a TTL compatable squarewave for syncronizing other equipment to sine, triangle, square or pulse waveforms of the Main generator or the Ramp generator depending on the position of the SYNC selector switch (14). 50 ohm output impedance.

8. ATTENUATOR - Three slide switches provide 60dB of output waveform attenuation in 10dB steps.

9. AMPLITUDE - Allows 20dB continuously variable attenuation at the OUTPUT connector. In combination with the ATTENUATOR (8), provides a total attenuation of 80dB.

10. OFFSET - Enables DC OFFSET control (11).

11. DC OFFSET - Provides up to ±7.5 volts of variable DC offset of the waveform at the OUTPUT connector, open circuit. ±3.75 volts into 50 ohms.

12. OUTPUT - Main output BNC connector outputs the waveform selected by the FUNCTION (13) switch. 50 ohm output impedance. 30 V P-P maximum into an open circuit.

13. FUNCTION - Selects the output waveform desired: sine, triangle, square, positive or negative pulse.

14. SYNC - Selects a syncronizing signal from either Ramp generator or Main generator.

15. LED's - Indicate the selected START FREQUENCY and STOP FREQUENCY dial mode and index the dial settings. If the start and stop modes (as selected by their respective inner dials) are not the same, the LED's will flash on and off indicating an improper combination.

16. STOP FREQUENCY DIALS - Operate like the START FREQUENCY DIALS but only to set the stop frequency when SWEEP is selected (2).

17. TRIG LEVEL - Adjusts trigger sensitivity from about 200 mV (MAN) to 15V (MAX).

18. RANGE - HZ - Selects the desired Main generator frequency range.

19. START LEVEL - Adjust start phase of Main generator waveforms over a $\pm 90^{\circ}$ range when PULSE or BURST is selected. Allows user to produce haversine and $\sin^2$ waveforms.

20. VAR SYMMETRY - Allows adjusting Main generator time symmetry over a range of 19:1 to 1:19 when VAR SYM switch (3) is in.

21. START FREQUENCY DIALS - Can be operated in any of three different modes with LED's indicating the mode.

    a. Dual Dial Mode: The inner dial sets the Main generator frequency (or sweep start frequency) from 1 to 10 times the RANGE - HZ setting in ten steps. The outer dial then allows continuous settings between the inner dial settings, providing 10-turn type resolution and 10% overrange reading the LIN scale. In this mode, sweep and VCF operations are linear.

    b. Linear Continuous Dial Mode: With the inner dial set to the "DIAL" position, the outer dial linearly sets the Main generator frequency (or sweep start frequency) from 0.01 to 10 times the RANGE - HZ switch setting. An LED indicates the frequency setting on the LINear scale. In this mode, sweep and VCF operations will be linear.

    c. Logarithmic Continuous Dial Mode: With the inner dial set to the "LOG" position, the outer dial logarithmically sets the Main generator freauency (or sweep start frequency) from 0.01 to 10 times the RANGE - HZ switch setting. An LED indicates the frequency setting on the LOGarithmic scale. In this mode, sweep and VCF operations are logarithmic.

22. RAMP/STEP Mode Switches - Provides four different Ramp generator operating modes:

    a. STEP/RAMP - Pushbutton switch selects continuous ramp (out) waveform or a step (in) waveform (staircase waveform) with 11 levels. The duration of each step level is selected with the RAMP/STEP TIME and MULTIPLIER switches. Note: The RAMP reset time is also included in the STEP duration.

b. TRIG MODE - Two pushbuttons select SINGLE (triggered), GATE or RUN. Both pushbuttons must be OUT for RUN. When SINGLE is selected a trigger pulse either externally (27) or manually (23d) will cause a single ramp waveform to occur. Especially useful for adjusting/measuring the start frequency while in SWEEP mode (2). When GATE is selected the Ramp generator will free run as long as the trigger pulse is in the active state of as long as START/RESET is depressed. The last ramp is completed and reset to zero volts.

c. HOLD - Allows holding the ramp output at the peak +2 V. Especially useful for adjusting/measuring the stop frequency while in the SWEEP mode (2).

d. START/RESET - Momentary pushbutton allows manual triggering of the Ramp generator.

23. START.....STOP LEDS - Indicate the present step level when operating in STEP mode.

24. MULTIPLIER - Allows adjusting the ramp time interval for 1 to 10 times the RAMP/STEP TIME (25) setting with 10-turn type resolution.

25. RAMP/STEP TIME - Selects the Ramp generator ramp time interval. Ramp reset time is not included.

26. EXT TRIG IN - BNC connector accepts signals for externally triggering or gating the Main generator. DC coupled with an input impedance of 1 K Ohms and a sensitivity of 200 m V.

27. RAMP/STEP TRIG IN - Rear panel BNC connector accepts signals for externally triggering and gating the Ramp generator. DC coupled with an input impedance of 5 K Ohms.

28. RAMP/STEP OUT - Rear panel BNC connector provides a 2V peak ramp output with a 600 Ohm output impedance.

29. VCF IN - Rear panel BNC connector allows external frequency control, Frequency Modulation, or frequency sweeping of the Main generator. Note that this input will control the frequency logarithmically when "LOG" is selected on the START FREQUENCY inner dial. A 0-5V input will vary the frequency 1000:1.

30. V:f OUT - Two rear panel BNC Connectors, (One for LINEAR and the other for LOG) provide output voltage proportional to frequency. The outputs are approximately 5V for a 1000:1 frequency range.

31. LINE VOLTAGE - Recessed slide switch on rear panel selects the line voltage at which the instrument will be operated.

32. FUSE - The line fuse is located on the rear panel. Always use the correct fuse for the line voltage of operation.

In the following detailed operating instructions, instrument labels are capitalized. The paranthesized numbers following these labels refer to the front panel familiarity photo at the beginning of this section. The accompanying waveforms apply to their respective instructions in a general way and do not necessarily represent the examples. They do show phase relationships. All waveforms have been obtained with the oscilloscope externally triggered from the 737 SYNC OUT (7).

1. Single Frequency continuous waveforms:

   a. Set the START FREQUENCY (21) inner dial to the first digit of the desired frequency and the outer dial to the second (and third) digits. If the frequency must be set precisely, use a frequency counter.

   b. Select the frequency decade with the RANGE-HZ (18) switch.

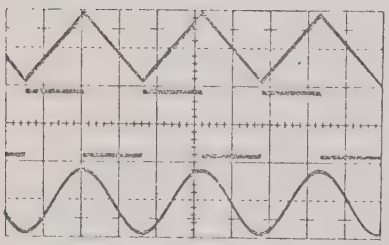
   c. Depress the FREE RUN (4) switch.

   d. Select the desired waveform with the FUNCTION (13) switch.

   e. Adjust the output amplitude using the ATTENUATOR (8) switches and the AMPLITUDE (9) control.

   f. If the ramp signal is not being used concurrently, the RAMP MODE (22) switches should not be in the RUN position to minimize any potential crosstalk. (Sensitivity to crosstalk is minimum at the higher start/stop frequency dial settings or when in the LOG mode.)

Example: We want a 455 KHz sinewave.



RANGE-HZ	100K
START FREQ inner dial	4
START FREQ outer dial (interpolating the last digit)	.55 linear scale
FREE RUN	Engaged
FUNCTION switch	SINE
SYN SELECTOR SWITCH	MAIN

2. Sweep frequency continuous waveforms:

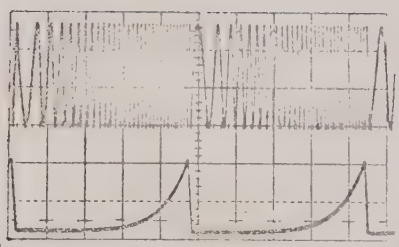
a. Frequency sweeping can be done either linearly or logarithmically, manually, internally using the ramp generator, or externally via the VCF INPUT (29).

b. For a manual linear sweep, set the generator up as described by "single frequency continuous waveforms" and sweep using the outer dial. For wider linear sweeping (up to 1000:1), set the START FREQUENCY (21) inner dial to DIAL and sweep using the START FREQUENCY (21) outer dial.

c. For a manual logarithmic sweep (up to 1000:1), set the generator as described by "single frequency continuous waveforms", change the START FREQUENCY (21) inner dial to LOG, and sweep using the START FREQUENCY (21) outer dial.

Example: We want to manually logarithmically sweep between 100 Hz and 100 KHz sinewave output.

FUNCTION	SINE
FREE RUN	Engaged
RANGE-HZ	10K
START FREQ inner dial	LOG
START FREQ outer dial	Manually rotate from end to end (0.01 times the range to 10 times the range).



1. Sine frequency logarithmic sweep up
2. V:f output.

d. For an internal linear sweep up, set the generator as follows:

(1) Engage the SWEEP (2) switch.

(2) Engage the FREE RUN (4) switch.

(3) Engage the SINGLE ramp TRIG MODE (22) switch.

(4) Engage the ramp HOLD (22) switch. Using a short ramp time, momentarily engage the START/RESET (22) switch.

(5) Set the RANGE-HZ switch (18) and STOP FREQ (16) dials to obtain the frequency you want the sweep to stop at (the high frequency).

(6) Momentarily depress the START/RESET switch.

(7) Set the START FREQ (21) dial to obtain the frequency you want the sweep to start at. (If the sweep will extend into two or more decades, set the START FREQ (21) inner dial to DIAL).

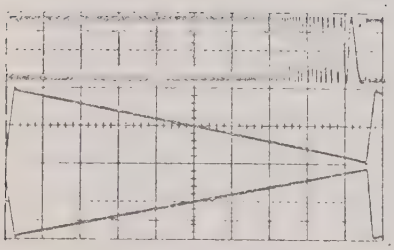
(8) Change the ramp mode to RUN by again depressing the SINGLE switch to release it.

(9) Adjust the RAMP/STEP TIME (25) and MULTIPLIER (24) to obtain the desired sweep time. (be sure the sweep time is adequate...for a 10:1 frequency sweep we suggest that the sweep time be 10 times the period of the lowest frequency; for 1000:1 we suggest 1000 times the period.)

For a linear sweep down, set the start frequency before setting the stop frequency.

Example: We want to linearly sweep a triangle wave from 8.7KHz to 2.4KHz twice each second using the internal ramp generator.

FUNCTION	TRIANGLE
SWEEP switch	Engaged
RANGE-HZ	1K
STOP FREQ inner dial	2
STOP FREQ outer dial	.4
START FREQ inner dial	8
START FREQ outer dial	.7
RAMP MODES	RUN (SINGLE and GATE out, RAMP TRIGGER engaged STEP/RAMP In RA
RAMP TIME	100 msec
MULTIPLIER	5.0
SYNC SELECTOR SWITCH	RAMP



1. Linear sweep down
2. V:f output
3. Ramp output

e. For an internal logarithmic sweep up, set the generator as follows:

(1) Engage the SWEEP (2) switch.

(2) Engage the FREE RUN (4) switch.

(3) Engage the SINGLE ramp TRIG MODE (22) switch.

(4) Set the RANGE-HZ (18) switch to the range required for the frequency you want the sweep to stop at (the highest frequency).

(5) Adjust the STOP FREQ (16) outer dial for the frequency you want the sweep to stop at.

(6) Momentarily engage the ramp START/RESET (22) switch.

(7) Adjust the START FREQ (21) outer dial for the frequency you want the sweep to start at (the low frequency).

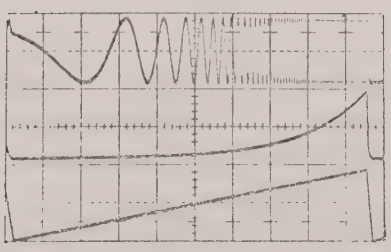
(8) Change the ramp mode to RUN by again engaging the SINGLE switch to release it.

(9) Adjust the RAMP/STEP TIME (25) switch and MULTIPLIER (24) to obtain the desired sweep time. For best results, make the sweep time as long as is compatible with your requirements. (For a 1000:1 sweep (3 decades), we recommend the sweep time be at least 10 times the period of the lowest frequency, more if possible.)

For a logarithmic sweep down, set the start frequency before setting the stop frequency.

Example: We want to logarithmically sweep a sinewave from 100Hz to 100 KHz.

FUNCTION	SINE
SWEEP switch	Engaged
RANGE-HZ	10K
STOP FREQ inner dial	LOG
STOP FREQ outer dial	10(top of dial)
START FREQ inner dial	LOG
START FREQ outer dial	0.01 (bottom or dial)
RAMP MODES	RAMP TRIGGER engaged, RUN, (SINGLE and GATE out, STEP/RAMP in RAMP
RAMP TIME	10 sec
MULTIPLIER	1.0
SYC SELECTOR SWITCH	RAMP



1. Logarithmic frequency sweep up
2. V:f output
3. Ramp output

b. Example 2: We want to logarithmically sweep up from 1HZ to 1KHZ and observe the frequencies at 11 steps.

Set up as follows:

	RANGE-HZ	100HZ
	START FREQ(inner dial)	LOG
	START FREQ(outer dial)	.01
	STOP FREQ(inner dial)	LOG
	STOP FREQ (outer dial)	10
	FUNCTION	
	SWEEP	Engaged
	FREE RUN	Engaged
	STEP/RAMP	Engaged
(Manual Stepping)	TRIG MODE (Ramp)	SINGLE
	RAMP/STEP TIME	1 sec or longer
	MULTIPLIER	ANY

Log Sweep

1. Output
2. Ramp Output
3. Log V:f Output

When stepping through a 1000:1 log sweep, the frequencies will be approximately one octave apart. To set up for more than one frequency per octave, the STOP FREQ setting can be calculated by using the following equation:

$$\text{STOP FREQ} = (2)^{\frac{10}{n}} \times \text{START FREQ}$$

Where n=number of frequencies desired per octave. For more than one frequency per decade: $\text{STOP FREQ} = (10)^{\frac{10}{n}} \times \text{START FREQ}$. Where n= number of frequencies per decade.

4. Single Cycle:

a. Depress the FREE RUN (4) switch.

b. Select the desired waveform with the FUNCTION (13) switch.

c. Set the frequency of the waveform with the START (21) dials, and the RANGE-HZ (18) switch (see instruction #1).

5. Unipolar sine and triangles (Haversine and Havertriangle) single cycles:

a. Set up the generator as described in instruction #4 and adjust the START LEVEL(19)in either the clockwise or counter-clockwise directions to get the waveform. (Too far may cause free running.)

b. Using the ATTENUATOR (8) switches and the AMPLITUDE (9) control, adjust the output for the peak to peak voltage required. (The AMPLITUDE (9) must be set for less than half amplitudes to prevent clipping when step "c" is performed.)

c. Engage OFFSET SWITCH (10) and adjust the DC OFFSET CONTROL (11) so the desired waveform peak is at 0 Volts.

FREQUENCY MODULATION:

a. Select the desired carrier waveform with the FUNCTION (13) switch.

b. Engage the FREE RUN (4) switch.

c. Set the carrier frequency with the RANGE-HZ switch and the START FREQ (21) inner and/or outer dials.

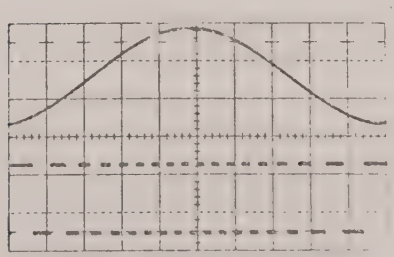
d. Apply the modulating signal to the VCF INput (29) on the rear panel.

The sensitivity of the VCF input is approximately 2 times the RANGE-HZ setting per volt. (0 to +5 shifts the frequency from 0.01 of range to 10 times range and 0 to -5V shifts the frequency from 10 times range to 0.01 of range.)

Example:

RANGE-HZ set at	100K
START FREQ set at	3.3 (330 Hz)
VCF sensitivity	200 KHz per volt
0.01V P-P signal at VCF input gives	± 1 KHz deviation (329 to 331 KHz)

In no event should the VCF input signal exceed 5V P-P.



d. Release FREE RUN (4) switch and depress the TRIG MODE PULSE (5) switch.

e. Apply a trigger signal (at least +200 mV peak) to the TRIG IN (26) connector with the TRIG SOURCE INT (6) switch out, or engage the MANual (6) pushbutton. One complete cycle will be produced for each trigger input.

If you want the generator to repetitively produce single cycles, continue as follows:

f. Engage the TRIG SOURCE INT (6) switch.

g. Adjust the TRIG LEVEL (17)

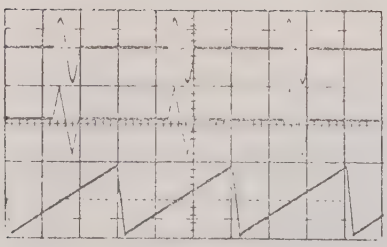
h. Set the ramp mode to RUN (SINGLE and GATE out).

i. Adjust the RAMP/STEP TIME (25) and MULTIPLIER (24) to obtain the desired repetition rate.

j. Adjust the START LEVEL (19) control for the desired start/stop phase of the cycle (sine and triangle only).

Example: We want to produce single cycles of 5 KHz sinewaves (starting at 180° and ending at 180°) one milli-second apart.

FUNCTION	SINE
TRIG MODE	PULSE switch engaged
RANGE-HZ	1K
START FREQ (inner dial)	5
START FREQ (outer dial)	0
TRIG LEVEL	CCW
RAMP/MODES	RUN (SINGLE and GATE out)
RAMP/STEP TIME	1 msec
MULTIPLIER	1.0
START LEVEL	Centered (adjust as needed)



1. 180° to 180° sine pulses
2. 180° to 180° triangle pulses
3. Ramp output

4. Unipolar square pulses:

a. If a square unipolar pulse is desired, set up the generator as described in instruction #4, and select the desired polarity with the FUNCTION (13) switch.

b. A positive TTL pulse is available at the SYNC OUTput (7).

(4) Sweeping with the internal ramp and using the Linear V:f output provides an output of approximately 0.5V for each frequency change equal to the RANGE-HZ(18) switch setting.

(5) Sweeping with the internal ramp and using the RAMP/STEP OUTPUT (28) provides a 0 to +2V ramp regardless of the sweep range.

a. With a full 1000:1 linear sweep range, this voltage changes 0.5V for each frequency change equal to the RANGE-HZ setting.

b. With a full 1000:1 logarithmic sweep range, this output changes approximately 1.6V per decade of frequency change.

RAMP STEPPED SWEEP MODE

3. By sweeping the main generator with a stepped ramp, you can generate at least one full cycle of each frequency within the sweep. The ramp, (which can be held at each of 11 levels) can provide either linearly or logarithmic sweep. The stepping can be triggered or continuous.

a. Example 1: We want to examine different sine wave frequencies within a linear sweep up from 1MHZ to 11MHZ in 1MHZ steps.

Set up as follows:

RANGE - HZ	1M
START FREQ(inner dial)	1
START FREQ(outer dial)	0
STOP FREQ (inner dial)	10
STOP FREQ (outer dial)	X
FUNCTION	
SWEEP	Engaged
FREE RUN	Engaged
STEP/RAMP	Engaged
TRIG MODE(Ramp)	SINGLE
RAMP/STEP TIME	Any
MULTIPLIER	Any

(Manual Stepping)

1. Output
2. V:f Output
3. Ramp Output

When the START-STOP LEVEL LEDS (23) indicate Start, the frequency will be 1MHZ, and each time the START/RESET (22) pushbutton is actuated, the frequency will increase by 1MHZ.

When STOP (23) level is reached, the frequency will at this point be 11 MHZ, and by actuating the START/RESET (22) pushbutton, the ramp will return to START (23) level, where the frequency will return to 1MHZ. LEDS (23) will indicate the level at which the ramp is holding. Automatic Stepping is obtained when the TRIGGER MODE (22) is in RUN (disengaging SINGLE and GATE simultaneously.)

f. For external sweeping, set the generator as described for manual sweeping and apply a sweeping voltage to the VCF INPUT (29). This voltage should not exceed 5V peak of either polarity, nor should it exceed 5V P-P. Use a 0 to +voltage for sweeping up from the dial setting and a 0 to -voltage for sweeping down from the dial setting. Do not attempt to sweep above (below) the maximum (minimum) dial frequency.

g. If desired, you may drive the horizontal axis of an oscilloscope or X-Y recorder with either of the V:f outputs (30) or the RAMP OUTPUT (28).

(1) When manually sweeping, you will have to use one of the V:f OUTPUTS (30). This provides a 0 to +5 output for a full sweep of 1000:1. The output is approximately 0.5V for each frequency change equal to the RANGE-HZ (18) switch setting.

V:f OUTPUTS

(2) With the main generator in either the LINEAR or LOG mode, (21) the LINEAR V:f OUTPUT (30) can be used to drive an X-Y recorder, or the horizontal axis of an oscilloscope. This allows a linear display of a manual sweep, which is useful in identifying specific frequencies within the range of the selected start and stop values. (For convenience, use a sweep which is wide enough to supply sufficient amplitude at the V:f OUTPUT (30) to provide full-width coverage of the oscilloscope.)

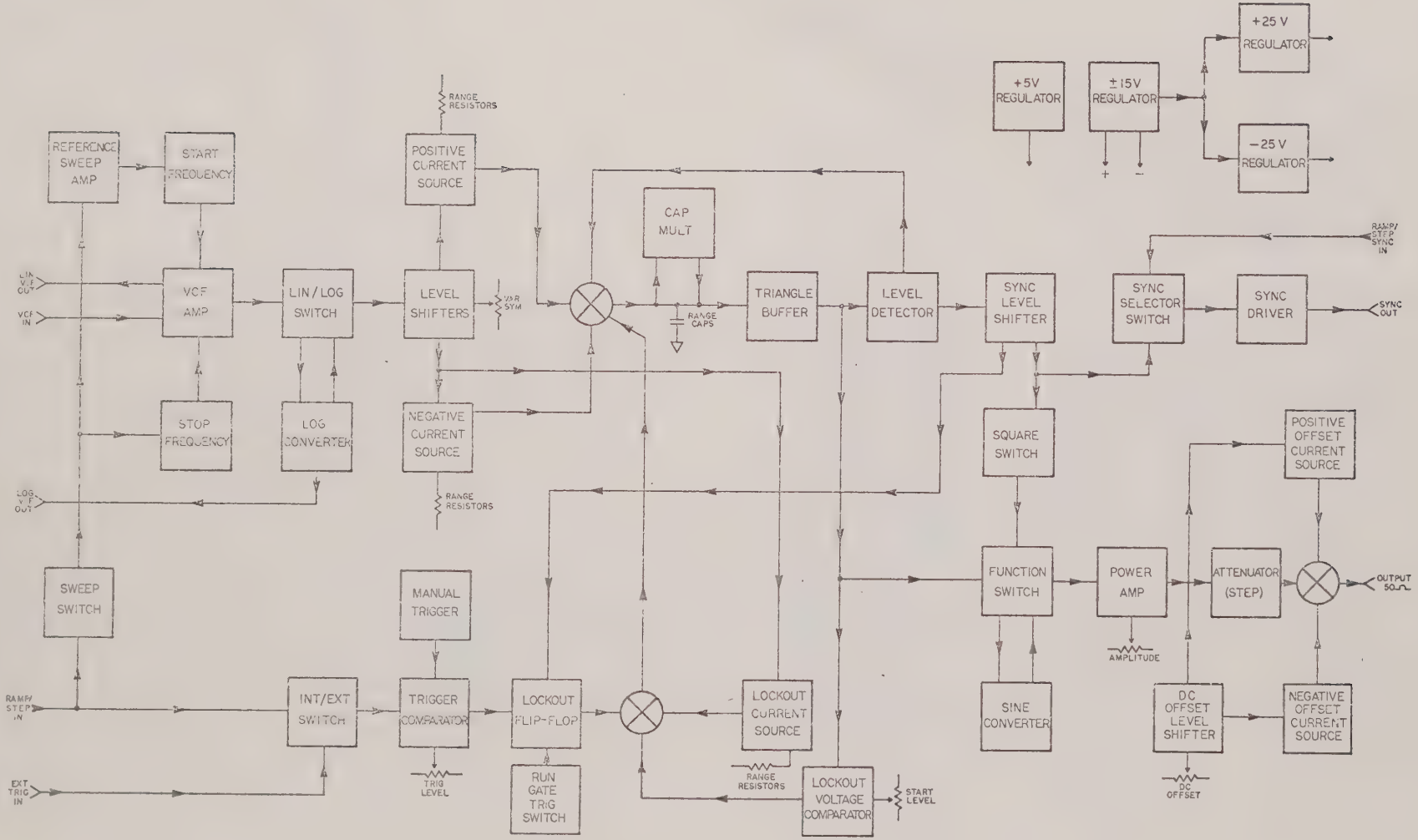
1. Output
2. Linear V:f Output
3. Ramp Output

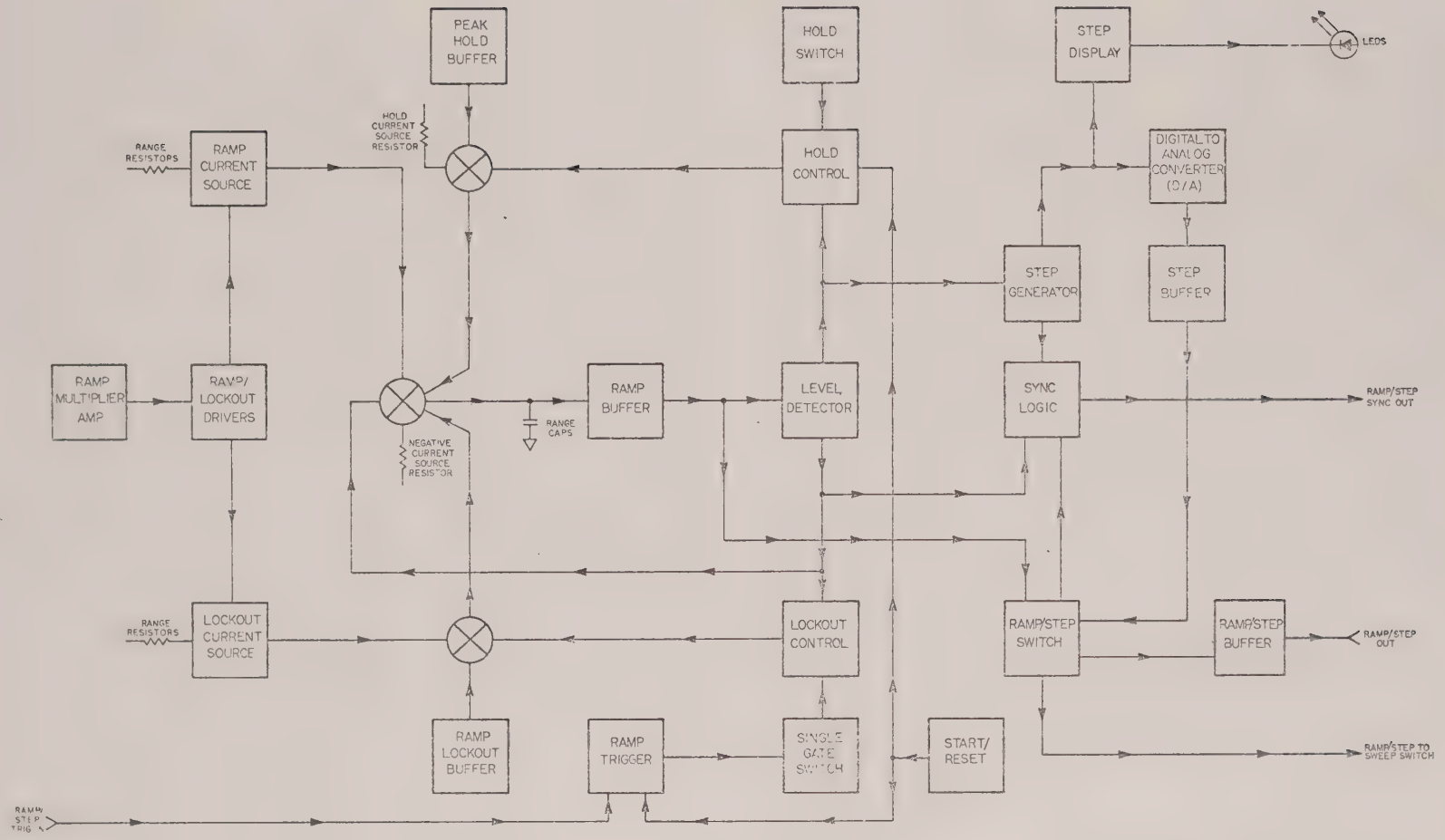
(3) Set the main generator in the LOG mode. (21) The LOG V:f OUTPUT (30) will now provide a V:f at a logarithmic rate.

1. Output
2. Logarithmic V:f Output
3. Ramp Output

SECTION 3

CIRCUIT DESCRIPTION


REFERENCE SWEEP AMP
START FREQUENCY
STOP FREQUENCY
VCF AMP
LIN/LOG SWITCH
LOG CONVERTER
LEVEL SHIFTERS
RANGE RESISTORS
POSITIVE CURRENT SOURCE
NEGATIVE CURRENT SOURCE
RANGE RESISTORS
CAP MULT
RANGE CAPS
TRIANGLE BUFFER
LEVEL DETECTOR
SYNC LEVEL SHIFTER
SYNC SELECTOR SWITCH
SYNC DRIVER
SYNC OUT
RAMP/STEP SYNC IN
+5V REGULATOR
±15V REGULATOR
+25 V REGULATOR
−25 V REGULATOR
SQUARE SWITCH
POSITIVE OFFSET CURRENT SOURCE
FUNCTION SWITCH
POWER AMP
ATTENUATOR (STEP)
OUTPUT 50Ω
AMPLITUDE
SINE CONVERTER
DC OFFSET LEVEL SHIFTER
NEGATIVE OFFSET CURRENT SOURCE
DC OFFSET
SWEEP SWITCH
MANUAL TRIGGER
INT/EXT SWITCH
TRIGGER COMPARATOR
TRIG LEVEL
LOCKOUT FLIP-FLOP
RUN GATE TRIG SWITCH
LOCKOUT CURRENT SOURCE
RANGE RESISTORS
LOCKOUT VOLTAGE COMPARATOR
START LEVEL
RAMP/STEP IN
EXT TRIG IN
LIN VCF OUT
VCF IN
LOG VCF OUT
V>R SYM


PEAK HOLD BUFFER
HOLD SWITCH
STEP DISPLAY
LEDS
HOLD CURRENT SOURCE RESISTOR
RANGE RESISTORS
RAMP CURRENT SOURCE
HOLD CONTROL
DIGITAL TO ANALOG CONVERTER (D/A)
STEP GENERATOR
STEP BUFFER
RAMP MULTIPLIER AMP
RAMP/ LOCKOUT DRIVERS
RAMP BUFFER
LEVEL DETECTOR
SYNC LOGIC
RAMP/STEP SYNC OUT
RANGE CAPS
NEGATIVE CURRENT SOURCE RESISTOR
RANGE RESISTORS
LOCKOUT CURRENT SOURCE
LOCKOUT CONTROL
RAMP/STEP SWITCH
RAMP/STEP BUFFER
RAMP/STEP OUT
RAMP LOCKOUT BUFFER
RAMP TRIGGER
SINGLE GATE SWITCH
START/ RESET
RAMP/STEP TO SWEEP SWITCH
RAMP/ STEP TRIG

MAIN GENERATOR CIRCUITS

The main generator is a triangle generator loop. A precision voltage source supplied by a Kelvin-Varley voltage divider, (the frequency multiplier control on the front panel) is summed at a voltage controlled frequency amplifier with the voltage controlled frequency (VCF) input for external frequency control. The output of the VCF amp is routed to the level shifters to generate the voltage levels necessary to drive the positive and negative current sources. The VCF amp also drives the linear voltage proportional to frequency buffer amp whose output is connected to the lin V:F BNC located on the rear panel. The LOG converter is also driven by the VCF amp, which in turn drives the LOG buffer amp whose output is connected to the LOG V:F BNC located on the rear panel.

The positive and negative current sources are voltage to current converters whose current output is determined by the voltage applied to them by the level shifters and current range resistors. The current range resistors and capacitor are selected with the frequency range switch. The voltage applied to the current sources is determined by the setting of the frequency multiplier control. Both these controls are located on the front panel. VCF IN will modify this voltage allowing external frequency control or sweeping. The RANGE/Hz sets frequency range.

The negative current source also drives a lock-out current source which is used in the PULSE and BURST modes of the main generator to be discussed later. This current source tracks the negative current source and also has current range resistors which are selected with the RANGE/Hz switch.

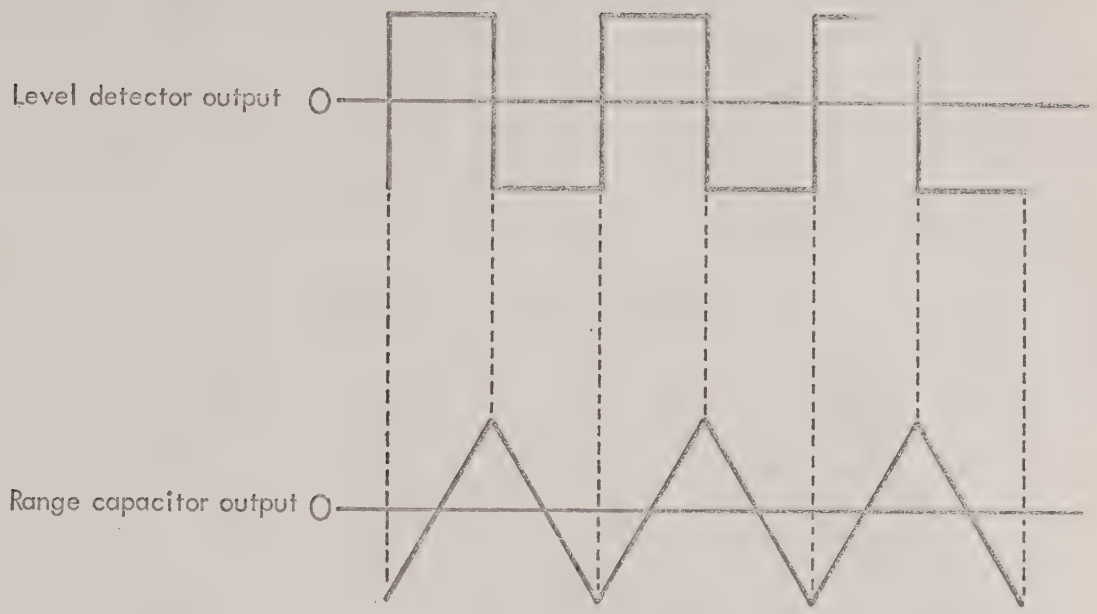
On the lower frequency ranges, a capacitance multiplier is switched into the circuit where the range capacitor would normally be. The cap multiplier has the capability of making a small capacitor function as if it's value were much greater than it really is. This allows realistic values of timing capacitors to be used on the very low frequency ranges.

The current source outputs are switched into the selected timing capacitor selected by the frequency range switch. This occurs via a diode switching bridge controlled by the output of the level detector, a bi-stable switch with fixed switching levels. The triangle buffer isolates the Range capacitor from the level detector.

The circuits just discussed comprise the basic generator loop for triangle and square wave generation. Assume that the level detector output is in the state that allows the positive current source to supply current to the timing capacitor. The capacitor will start charging linearly. The rate of charge or slope will depend on:

1. The size of the capacitor.
2. The current supplied by the positive current source.

When the capacitor reaches the preset voltage of the level detector, the output of the level detector switches and the negative current source starts supplying current to the range capacitor. Since the negative current source is a mirror of the positive current source, the charging rate is the same but opposite in polarity. The range capacitor charges to the negative preset voltage of the level detector and the level detector switches again. The positive current source once again supplies current to the range capacitor. The following figure shows the result.



The action is continuous, and the result is a triangle and square wave of the same frequency available at the outputs of the triangle buffer and level detector respectively. The frequency is determined by the selected range capacitors and resistors and the current supplied by the sources. This current can be changed by the voltage applied to the current sources, therefore, the front panel Frequency Multiplier and VCF input determine the frequency within the selected Frequency Range.

Both triangle and square waveforms are delivered to the FUNCTION switch which selects either triangle or square wave or supplies the triangle to the SINE CONVERTOR in the SINE position. The SINE CONVERTOR uses shaping and amplifing circuits to convert the triangle to a sinusoidal waveform of equal amplitude to the triangle. The square wave is attenuated to half amplitude and offset all positive with respect to ground in the positive pulse position of the FUNCTION switch and all negative in the negative pulse position. This allows an additional pulse mode in the PULSE or BURST modes of the main generator. The pulse width is adjustable with the RANGE-HZ switch and the START FREQUENCY switch. The repitition rate is equal to the external clock applied to the EXT TRIG IN connector or if INTernal TRIG SOURCE is selected the repitition rate is adjustable with the RAMP/STEP TIME switch and the MULTIPLIER switch. The pulses can be activated by depressing the MAN button as well. The selected waveform is delivered to the AMPLITUDE control on the front panel. The AMPLITUDE control provides a 20 dB continuously variable control of the amplitude of the selected waveform. The AMPLITUDE control delivers the selected waveform to the power amplifier. The signal is amplified to a maximum of 30V P-P by the power amplifier.

Additive, individually front panel switched attenuators of 10, 20 and 30 dB provide a total of 60 dB increments. Post attenuator D.C. offset is provided by positive and negative current sources controlled by a front panel D.C. OFFSET adjustment that controls D.C. OFFSET level shifting circuitry. The output of the level shifter controls the current that is summed after the output attenuators. This allows ±7.5V of D.C. offset that is unaffected by attenuator settings.

The square wave from the level detector is also delivered to the SYNC SELECTOR switch on the front panel. This switch selects either the square wave from the level detector of the RAMP SYNC PULSE from the RAMP GENERATOR circuitry. The output of the SYNC SELECTOR switch is level shifted and available at the SYNC OUT BNC on the front panel.

When the PULSE pushbutton is engaged, the lock out current source is summed in the RANGE capacitor with the current from the + current source, preventing the charge on the RANGE capacitor from changing. The LOCK OUT comparator compares the output of the triangle buffer to the level set by the START LEVEL CONTROL which determines the level of the waveform at which lock out occurs. When an External Trigger signal overcomes the level set by the trigger level set by the trigger level control, the LOCK OUT control flip flop switches and diverts the current from the LOCK OUT current source allowing the generator to start to run. The second transition of the level detector resets the LOCK OUT control flip flop, allowing the LOCK OUT current source to lock the generator out again when it reaches the level set by the START LEVEL phase control on the front panel. One complete cycle is generated for each External input trigger signal, the starting and stopping level or phase controlled by the START LEVEL control.

When the BURST pushbutton is engaged the operation is the same, except the LOCK OUT control flip flop reset is inhibited as long as an external gate signal is applied. The LOCK OUT flip flop resets on the proper transition of the level detector, after the gate signal is removed, which always guarantees an integer number of cycles.

POWER SUPPLY

The primary power for this instrument is supplied through the line cord to fuse F-1 which is selected for each voltage of operation. The power is then applied through the main power switch S-1 to the transformer primary and line voltage switch S-2. The Line Voltage switch S-2 selects the method of connection for the primary taps so that a selection is available as to which line voltage the instrument will operate at. Transformer T-1 steps down the operating potential of the input primary power so that the proper voltage is developed through the use of diodes D-4 through D-7 and filter capacitors C-3 and C-4. This full wave center tapped bridge rectifier provides both positive and negative operating potentials of sufficient magnitude to be regulated through the use of the plus and minus 15 volt regulator. Integrated circuit U-1 has self contained voltage reference and error amplifiers. The output of these error amplifiers are fed to series pass transistors Q-1 and Q-2 which enhance the current carrying capability of U-1. Resistors R-5 and R-7 are current sensing resistors that allow Q-1 and Q-2 to reduce the output voltage of the supply in the event the current reaches a predetermined value. The voltage feedback, necessary for the error amplifiers are derived through the use of potentiometers R-9 through R-11. The potentiometers R-9 and R-11 allow a vernier adjustment of the power supply voltages. Diodes D-8 and D-9 are used to prevent accidental application of reverse voltages to the regulator. Application of opposite polarity

voltage would damage the integrated circuit. Capacitors C-7 and C-8 prevent the build up of transient voltage at the output of the supply under varying load conditions.

Diodes D-1 and D-2 in conjunction with R-1 and C-1 form a positive voltage supply. Regulation for this supply is performed with a three terminal voltage regulator U-1 (rear panel). This type of regulator has an integral voltage reference and current sensing device that are preset and not adjustable. Diode D-3 is used to prevent accidental application of negative voltage to U-1 (rear panel), which would damage the regulator. Capacitor C-2 is used to enhance the transient response of the regulator under varying load conditions.

Diodes D-10 through D-13 and resistors R-12 and R-13 in conjunction with filter capacitors C-9 and C-10, provide both positive and negative operating potentials of sufficient magnitude to be regulated through the use of the two three terminal regulators U-2 (rear panel) and U-3 (rear panel). The operation of these two regulators is similar to U-1 (rear panel) described above. However, the common terminal is referenced to a variable voltage instead of ground. U-2 (power supply board) is the variable voltage source whose input is connected to voltage divider R-15, R-16 and R-17 referenced between plus and minus 15 volts. Potentiometer R-16 allows the voltage division to be adjustable and U-2 (power supply board) boosts the current handling capability before being routed to U-2 (rear panel). The normally fixed regulated voltage of U-2 (rear panel) pin 2 is now adjustable. Diode D-14 is used to prevent accidental application of negative voltage to U-2 (rear panel) which would damage the regulator. Capacitor C-11 is used to enhance the transient response of the regulator under varying load conditions.

U-3 (rear panel), U-3 (power supply board) and associated circuitry functions exactly as described above for U-2 (rear panel) and U-2 (power supply board) except that the regulator U-3 (rear panel) is for a negative voltage supply. Diode D-15 is used to prevent accidental application of a positive voltage to U-3 (rear panel) which would damage the regulator. Capacitor C-12 is used to enhance the transient response of the regulator under varying load conditions.

RAMP GENERATOR

The Ramp Generator circuitry is very similar to the Main Generator loop circuitry. The basic idea being the Constant Current Source charging and discharging the Timing Capacitor, and routing the capacitor voltage to the Ramp Buffer and to the Ramp Level Detector. One major difference in the Ramp Generator being the charging of the timing capacitors with a constant current source - Ramp Current Source - and the discharge being with a resistive current source. The ratio of these currents are set to provide a very fast reset ramp waveform. The Ramp Multiplier amp is a buffered operational amplifier whose output is applied directly to the Ramp Drive and Lockout Drive amplifiers which are positive and negative level shifters respectively. The output is also applied to the Multiplier Switch Control which is a Kelvin Varley Divider (KVD). This KVD then varies the feedback ratio such that rotation is proportional to the ramp pulse time.

The positive and negative level shifting amplifiers are closed loop variable voltage current output amplifiers. The voltage outputs at the collectors of the two level shifter amplifiers are opposite in polarity and referenced to the positive and negative 15 volt supplies. The positive signal is applied to the Ramp Current Source which is another

voltage variable current output amplifier buffered at the output with a single field effect transistor. Decade selection of the timing current is accomplished with the Ramp/Step Time switch. The ramp negative level shifting amplifier is used to drive the Ramp Lockout Current Source which operates at twice the current of the Ramp Current Source. This current source is a variable voltage closed loop current output amplifier whose output is buffered with a single field effect transistor. Decade values of current selection for this current source is accomplished with the Ramp/Step Time switch. The ramp lockout voltage is always zero volts so the lockout voltage is referenced to the Ramp Lockout Buffer which is adjustable to insure a precise zero volt lockout level. A diode switching arrangement allows the Lockout Current Source to be applied only when the proper signal has been applied to it from the Lockout Control circuit.

The Ramp/Step Time switch selects decade values of timing capacitors so that in conjunction with the variable Ramp Current Source a continuously variable ramp time may be obtained. The ramp reset current is supplied through the diode switching bridge with a single resistor referenced to a -15 volt supply. The voltage of the ramp waveform generated at the timing capacitors is applied to the Ramp Buffer. This buffer is a high impedance, field effect transistor whose output is applied to the base of an emitter follower for current gain to handle the load which it must feed. One of the loads is the Level Detector. This Level Detector operates much the same way as the Main Generator's Level Detector does except that the Trip Points are set at different levels. The ramp waveform is positive going so the Trip Points are set at about +2.5 volts and zero volts. The Level Detector has another section called Hysteresis Switch which is an amplifier to increase the drive capabilities of the Level Detector outputs to handle a heavier load. Two outputs are now available from the Level Detector and are 180° out of phase from each other. One phase is fed back to the diode bridge that controls the charging current to the timing capacitor; to the Sync Logic for proper synchronization to Ramp as well as Step waveforms; to the Lockout Control for proper lockout timing; and back to the Level Detector for the hysteresis action to cause the Level Detector to automatically switch at the preset Trip voltages. The other phase is routed to the Step Generator and to the Hold Control.

Lockout Control is enabled with the front panel controls, Single and Gate. When one of these pushbuttons is depressed Lockout Control is enabled. At the instant the Level Detector switches so the ramp is resetting, a pulse from the Level Detector is routed to the Lockout Control that switches an R/S flip flop. This TTL flip flop is then inverted and level shifted with a transistor differential pair and routed to the lockout diode switch thus enabling the Lockout Current Source and Ramp Lockout Buffer. When the ramp voltage matches the Ramp Lockout Buffer, the Lockout Current Source, now active, prevents any further voltage change on the timing capacitors. At this same instant the Level Detector switches states and causes the Ramp Current Source to dump current into the timing capacitors, but the voltage does not change because the Lockout Current Source absorbs this current and the output remains stable at zero volts. When a trigger pulse enters the Ramp/Step Trig In on the rear panel or the Start Reset button is pushed, a pulse is routed to the Lockout Control resetting the lockout flip flop. This disables the Lockout Current Source causing the voltage on the timing capacitor to increase at a linear rate thus producing another ramp waveform. If Single is depressed, only one ramp waveform will be generated and the output will return to a stable zero volts until another pulse enters the Ramp/Step Trig In or the Start/Reset pushbutton is released and depressed again. If Gate is depressed the ramp waveforms will be generated continuously for the duration of the active high state of the pulse at the Ramp/Step Trig In or until the Start/Reset pushbutton is released.

The Ramp Trig circuit is a Schmitt Trigger that accepts analog voltages from the Ramp/Step Trig In and changes this to a positive switching action that has two stable states, a requirement for digital circuitry to function properly. The Main Trig circuit is an R/S flip flop that accepts the Set and Reset signals from the Start/Reset pushbutton. This circuit outputs a pulse to the Hold Control and a DC level to the Ramp Trig circuit. Debouncing the switch contacts is the primary function of the Man Trig circuit.

The Hold Control circuit works very much the same as the Lockout Control except everything is inverted. The Hold Control is enabled by depressing the Hold pushbutton. The ramp waveform in this case is stopped at the peak of it's excursion +2.5V and remains stable at this voltage until a trigger pulse enters the Ramp/Step Trig In or the Start/Reset pushbutton is depressed. When this happens, the ramp waveform resets and then ramps up to the peak and stops until another pulse enters the Ramp/Step Trig In or the Start/Reset pushbutton is depressed again.

The Step Generator is basically a four-bit Digital to Analog converter whose output is not integrated but remains in the form of discrete voltage steps. One phase of the Level Detector is routed to a four bit binary counter that counts up one digit everytime the Ramp Generator generates one complete ramp waveform. The binary counter is wired with external logic so that it will count from zero to ten and then reset to zero again. It takes eleven ramps to make one complete staircase waveform. The four binary outputs of the counter are routed to the Step Display which is a BCD to Decade Decoder. A four bit binary number enters the decoder and leaves on one of ten discrete lines, of which only one line is activated for each unique binary number input. These output lines each drive a single Light Emitting Diode (LED) to indicate the present count or step level present at the Ramp/Step Out BNC.

The counter's four binary outputs are also routed to a diode gate arrangement. Each output line has a diode gate and a resistor with a value twice the resistance of the one next to it. The output of the diode gates are summed at the input of a fed back operational amplifier. The voltage at the input of this amplifier will not change because the feedback is returned to this same point creating a current mode input. In this way the output of the amplifier will change voltage level with a change of current applied to the input. The diode gates work in just this way. Each gate is opened and closed in a binary format allowing current to pass through the gate to the input of the amplifier. The amount of current is set by the value of the resistor corresponding to the gate that is open. When more than one gate is open the current adds, and a corresponding increase of voltage out of the amplifier occurs. In this manner the resistors are chosen to create equal voltage increases at the amplifiers output as the binary sequence is stepped through.

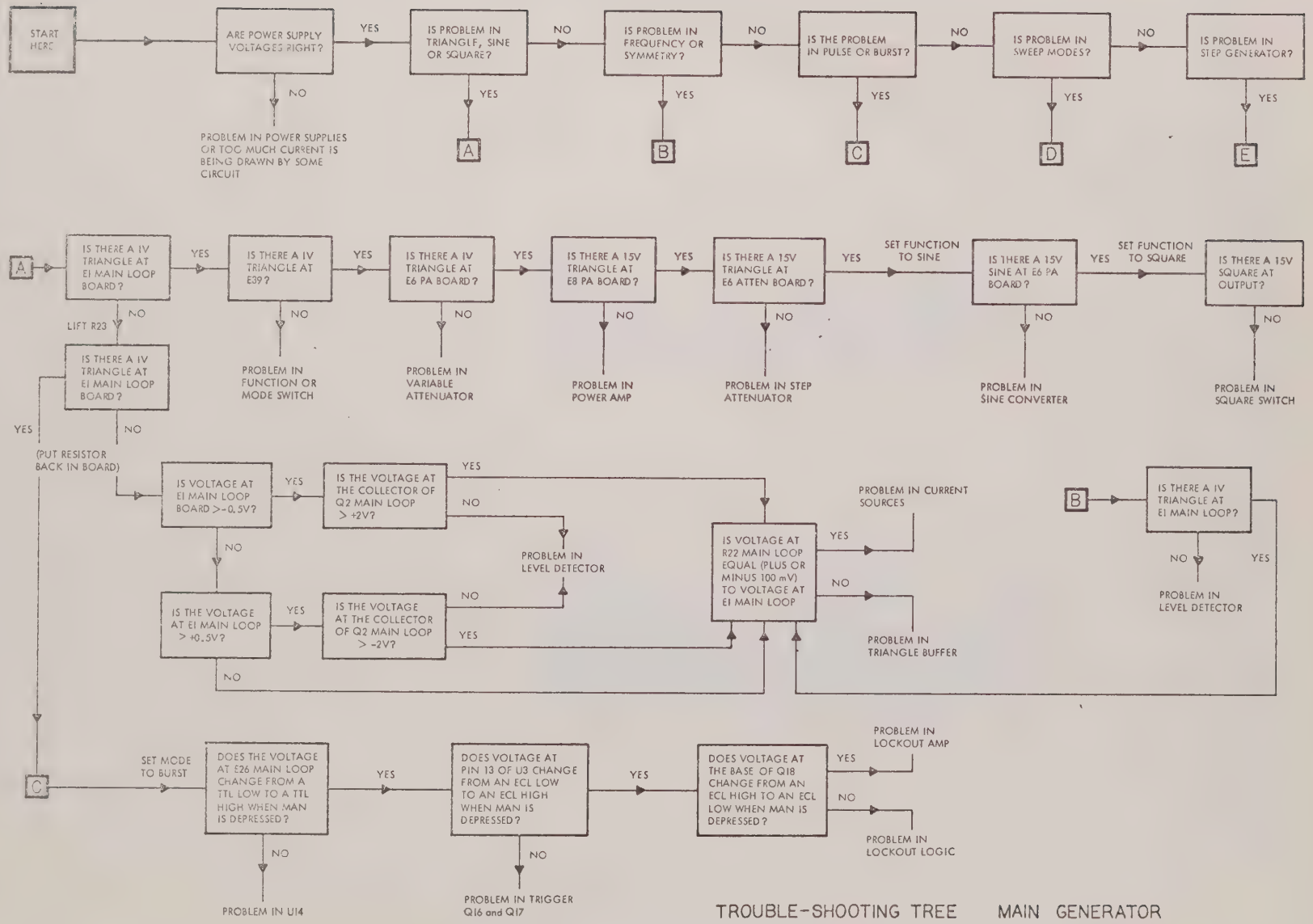
From the D/A, the Step signal is decoupled from it by means of the Step Buffer, a closed loop buffered operational amplifier. This buffer prevents any loading effects from interfering with the D/A's output voltage. The Step signal is routed to a switching arrangement that selects either the Step waveform or the Ramp waveform. While in the Ramp mode the Sync Logic will inhibit the Step Generator by placing a continuous Reset signal to the binary counter, thus the Start LED will remain on continuously in this mode. From the switch, the Ramp and Step signals are routed to the Sweep switch and to the Ramp/Step Buf. The Ramp/Step Buf is an emitter follower amplifier which adds adequate current gain to the signal to drive a 600 ohm output BNC, Ramp/Step Out. The switch also enables the proper Sync signal to be generated. The Sync signal is routed to a Sync Selector which selects either the Ramp Generator or the Main Generator as the source. Then it is routed to a driver that supplies the Sync Out port on the front panel, which is designed to be terminated into a 50 ohm system.

SECTION 4

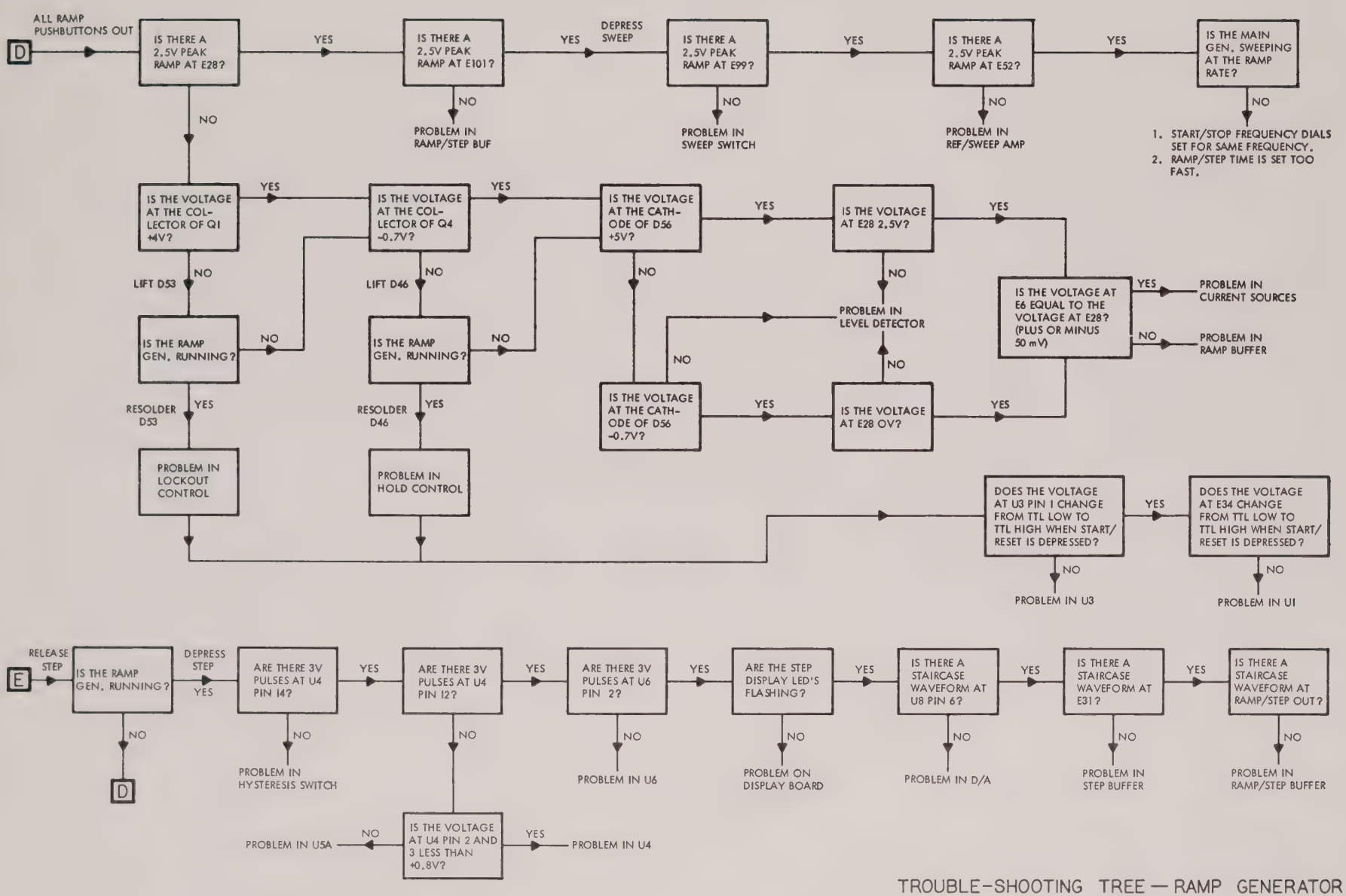
TROUBLE SHOOTING

The trouble shooting trees are designed to point to the malfunctioning circuit block. Beyond this, refer to the proper schematic and check voltages and waveform at the indicated points to determine the actual problem. Start with the following initial control settings on the Model 737.

START FREQUENCY	10.0
STOP FREQUENCY	1.0
RANGE/Hz	100
START LEVEL	CENTER
FUNCTION	TRIANGLE
SYNC	MAIN
VAR SYMMETRY	CENTER
TRIG LEVEL	MAN
AMPLITUDE	CW
DC OFFSET	CENTER
POWER	IN
SWEEP	OUT
VAR SYM	OUT
FREE RUN	IN
ATTENUATOR	OFF
DC OFFSET	OFF
RAMP/STEP TIME	10μ S
MULTIPLIER	1.0
RAMP/STEP	OUT (ALL)



TROUBLE-SHOOTING TREE MAIN GENERATOR



TROUBLE-SHOOTING TREE — RAMP GENERATOR

SECTION 5

CALIBRATION PROCEDURE

737 CALIBRATION PROCEDURE

1. SET CONTROLS :

MAIN -

POWER	IN
VAR SYM	OUT
FREE RUN	IN
INT	OUT
ATTENUATORS	OFF
DC OFFSET	OFF
START FREQ	10.0
RANGE- Hz	100
STOP FREQ	10.0
FUNCTION	TRI
AMPLITUDE	MAX
TRIG LEVEL	CENTER
VAR SYMMETRY	CENTER
START LEVEL	CENTER
SYNC	MAIN
DC OFFSET POT	CENTER

RAMP -

RANGE	1mS
MULT	1.0
ALL PUSHBUTTONS	OUT

Note: OUTPUT and SYNC OUT must be properly terminated into 50Ω for measurements.

2. Adjust +15V at E36 for +15.000V ± 2mV
   Adjust -15V at E41 for -15.000V ± 2mV
   Adjust +25V at E45 for +25.00V ± 10mV
   Adjust -25V at E47 for -25.00V ±10mV

   Check for +4.80V to 5.20V at E15

3. Adjust RAMP REF at E52 for 2.500V ± 1mV

4. Connect A x10 probe across C12 D and observe a triangle waveform on the oscilloscope. ADJUST the BUF DC so the triangle is symmetrical about ground. Disconnect the x10 probe and reconnect the terminated OUTPUT to the oscilloscope input.

5. Set the START FREQUENCY to DIAL and the large knob max CCW, set RANGE-Hz to 100K. Adjust the SEARCH RANGE adj. For - 10mV ±1mV at E74.

6. Adj SEARCH SYM A and SEARCH SYM B for a symmetrical period of about 1.2 MS on the oscilloscope.

7. Set the scope sweep speed to 1mS per division, then return the START FREQUENCY to 10.0 Switch the RANGE-Hz between 10K, 100K, and 1M. Adjust the TRI COMP with the RANGE-Hz in the 1M position so the triangle peaks are the same amplitude as in the 100K and 10K positions.

8. Return the RANGE-Hz to 100. Set the FUNCTION to sine. Adjust the +TRI PK and -TRI PK at E43 for ±0.460 V peak ±5mV. x 10 scope probe is required.

9. Connect the terminated SYNC OUT to a frequency counter. (Terminated SYNC OUT is TTL levels) Adjust the FREQ adj. for approx. 1KHz. Set the RANGE-Hz to 3M and adjust the 30MHz ADJ for approx. 30 MHz on the counter. Set the RANGE-Hz to 1M and adjust the 1MHz ADJ for approx. 10 MHz on the counter.

10. PA AMPLITUDE:
Set the RANGE-Hz to 100 FUNCTION to triangle. Connect the terminated output to a comparator oscilloscope.

    A. Set the AMPLITUDE to maximum CCW and set the scope sensitivity to 50MV per division. Adjust the PA OFFSET adj. for a waveform symmetrical about ground.

    B. Set the AMPLITUDE maximum CW and set the scope sensitivity for 100MV per division and the scopes comparison voltage to 8.000V. Adjust the PA GAIN for amplitude of 16.0V P-P. (The peaks will be offset from ground slightly).

    C. Repeat 15-A and B because there is some interaction.

11. SINE DISTORTION:
NOTE: It may be helpful to observe the distortion products on the oscilloscope. Set the FUNCTION to SINE. Observing the comparator scope adjust SINE DC for a waveform symmetrical about ground.

    A. Connect the terminated OUTPUT to a distortion analyzer.

    B. Adjust + and - TRI PK adj. for minimum distortion.

    C. Adjust + and - SINE DIST adj. A,B, and C for minimum distortion.

    D. Check the distortion at RANGE -Hz settings of 1K, 10K. Make adjustments as necessary for the best compromise. Typ. 0.3%.

    E. Set the RANGE -Hz to 10 and adjust LF SYM for lowest distortion.

    F. Set the RANGE -Hz to 3M. Connect a 20 db pad between the unterminated OUTPUT coax and the spectrum analyzer. Observe the harmonics, they should be more than 30 db below the fundamental. Adjustment of the BUF DC may be necessary to lower the 2nd harmonic.

12. MULT. KNOB
Return FUNCTION to triangle and RANGE -Hz to 100. Connect the terminated OUTPUT to an oscilloscope. Observing one or two cycles displayed on the CRT, turn the START FREQUENCY large knob. Notice that near the ends of rotation there is a "dead zone" where the frequency of the waveform displayed on the oscilloscope does not change as rapid as near the center of rotation. Adjust the large knob so that the "knee" where the "dead zone" starts is just past "x" on the LIN scale. Loosening of the set screws will be necessary for this adjustment. Make sure that the "knee" on the other end of the large knob is just below "0" on the LIN scale.

13. FREQUENCY
Set the FUNCTION to square wave and the START FREQUENCY to 100. Connect the terminated OUTPUT to a frequency counter. Adjust the FREQ adj. for 1.00KHz. Check the RANGE -Hz settings of 100, 1K, and 10K, a compromise may be necessary for all settings to meet spec. Set the RANGE -Hz to 3m and adjust the 30 MHz adj. for 30.0MHz. Set the RANGE -Hz to 1M and adjust the 1MHz adj. for 10.0 MHz.

14. Set the RANGE -Hz to 100K and install the "sel" capacitor. This is a mica capacitor approx. 22pf.

15. Set the RANGE -Hz to 10. Adjust the LOW FREQ adj. for 100 Hz. Check range Hz settings of .01, 0.1, 1, and 10, a compromise may be necessary for all settings to meet spec.

16. AMPLITUDE
Set the RANGE -Hz to 100 and FUNCTION to SINE. Connect the terminated OUTPUT to a comparator oscilloscope. Set the scope sensitivity for 100MV per division and the comparison voltage to 8.000V. Adjust the SINE DC adj. so the peaks are symmetrical about ground.

17. Set the FUNCTION to neg. pulse. Adjust the -SQ PK adj. for -8.00V peak.

A. Disengage the comparator offset on the scope. Adjust the PULSE DC adj. so the peaks are at ground level. Set the FUNCTION to pos. pulse and notice the DC shift. It may be necessary to readjust the PULSE DC so that the levels are equal about ground.

B. Set the FUNCTION to pos. pulse. Adjust the +SW PK for +8.00V peak.

18. P.A. RESPONSE
Set the FUNCTION to square wave. Adjust the AMPLITUDE so the square wave is 15 V P-P. Set the scope sweep speed to 50 ns per division. Set the RANGE -Hz to 1m. Adjust the START FREQUENCY so that one cycle is displayed. Adjust the SQ=50NS adj. For the flatest response in the 20nSTO 50 nS region immediately following the transition.

19. If overshoot is 75% adjust SEL capacitor to minimize overshoot in the 10nS to 20nS Region. Important: The SEL capacitor is adjusted by changing the spacing (Bending) of the two wires against the 2.00 K feedback resistor.

20. Some improvement of the high speed transitions can be obtained by adjusting the SQ L5nS adj. to effectively increase overshoot in the 5nS to 10nS region. This adjustment should be made with care, as amplifier stability can be affected. Stability can best be observed by setting the oscilloscope at 1 uS per division and RANGE -Hz and START FREQUENCY for two cycles to be displayed over the full screen. (approx. 200 KHz). Now switch the FUNCTION between pos and neg pulse and look for high frequency oscillations on the flat portions of the wave form.

21. LOG CONV.
Set the RANGE-Hz to 100K, FUNCTION to triangle, START FREQUENCY to DIAL and the large knob max.CCW. connect the terminated SYNC OUT to a frequency counter, the terminated OUTPUT to an oscilloscope. Set the scope sweep speed to 0.1 ms per division. Check to make sure that one cycle period is still about 1.2mS. It may be necessary to readjust SEARCH SYM A and B.

22. Set the START FREQUENCY to LOG and the large knob to 0.01, then adjust the LOG DC adj. for 1KHz.

23. Set the START FREQUENCY large knob to 10 and adjust the SPAN adj. for 1.00MHz.

24. Set the START FREQUENCY large knob to 0.01 and apply a voltage to the VCF IN (approx 5V) with a precision power supply. Adjust the precesion supply so the frequency counter reads 1.00MHz. Note the voltage applied and readjust the precision supply to exactly 1/2 this voltage. The frequency counter should read 31.6KHz, if not continue to step 25.

25. If the frequency reads above 31.6 KHz adjust the ORIGIN so the frequency reads below 31.6 KHz about as far as it was above. If the frequency reads below 31.6 KHz adjust the ORIGIN so the frequency reads above 31.6 KHz about as far as it was below.

26. Repeat steps 22 through 25, until the last part of step 24 comes out close to 31.6 KHz.

27. Set the START FREQUENCY large knob to 10. Observe the frequency counter reading. Carefully switch the START FREQUENCY to DIAL. Adjust the trimmer pot located on the START FREQUENCY switch so the counter reads the same frequency as it did in LOG.

RAMP GEN:

1- Connect a x10 probe to the scope and to E99 on the IS/PS board. Set the SYNC to RAMP.

2- Adjust the RAMP DC adj. so the bottom peak is at 0.00V ±2mV.

3- Depress SINGLE and adjust the RAMP LO adj for 0.00 ±2mV. Release SINGLE.

4- Adjust the RAMP PKadj so the top peak is at 2.50V ±2mV.

5- Depress HOLD and adjust the PK HOLD adj. for 2.50V ±2mV. Release HOLD.

6- Some interaction occurs therefore it may be necessary to repeat steps 2 through 5.

7- Depress STEP and adjust DC STEP adj. so the very bottom step is at 0.00V ±2mV. adjust the STEP GAIN adj. so the very top step is at 2.50V ±2mV. Release STEP.

8- Connect the terminated SYNC OUT to a time interval counter. Trigger the counter from the minus to plus transitions and adjust the PERIOD ADJ for for 1.0mS ±50uS. Check all other ranges from 1S to 1uS, a compromise may be necessary for them all to meet spec. (±5%)

SWEEP:

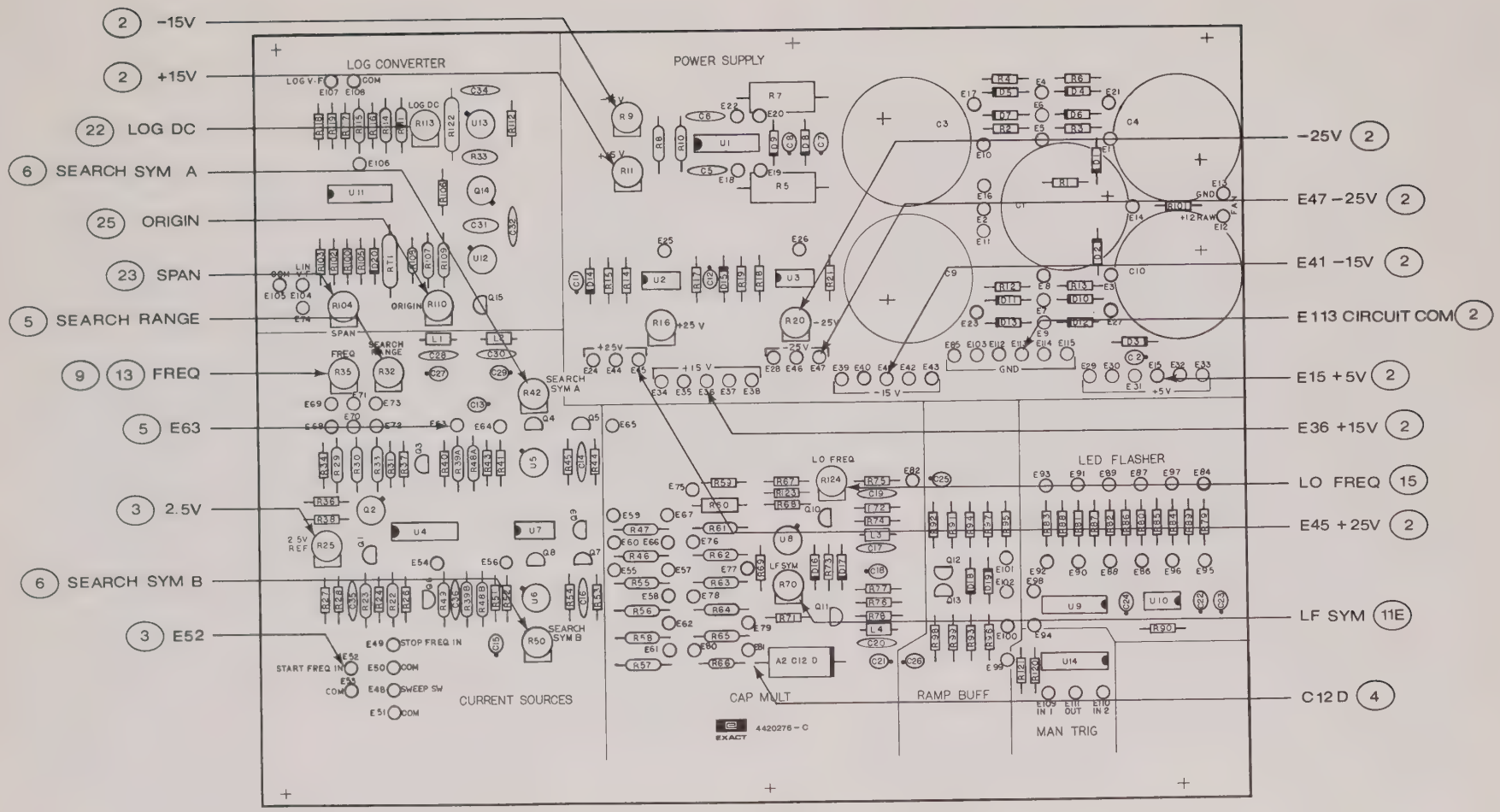
9- Connect the terminated SYNC OUT to a frequency counter and set the SYNC to MAIN.

10- Depress SWEEP, SINGLE, and HOLD in that order. Set the START FREQUENCY to LOG and the large knob to 10, do the same with the STOP FREQUENCY controls.

11- Observe the frequency counter, this is the START FREQUENCY setting. Depress START/RESET once, this is the STOP FREQUENCY setting. If the STOP FREQUENCY reading on the counter is not the same, turn the STOP FREQUENCY large knob until the counter reads the same as it did for the START FREQUENCY.

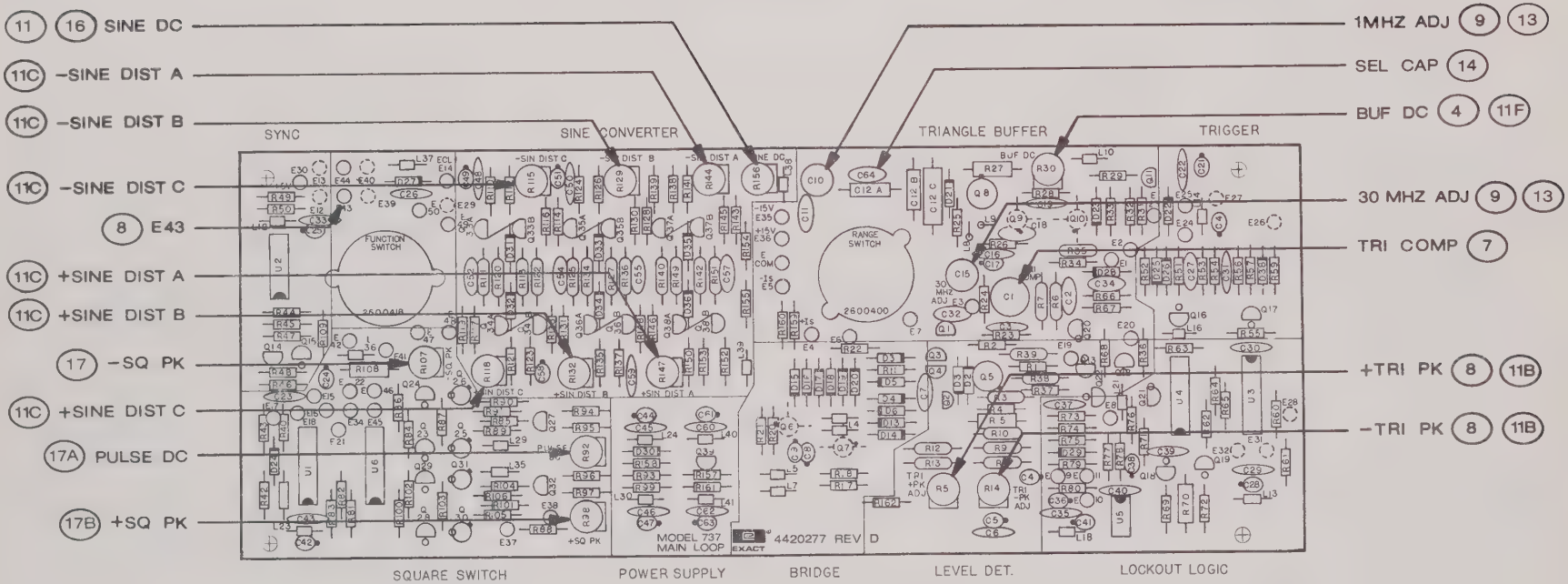
12- It may be necessary to loosen the set screws on the STOP FREQUENCY large knob to position it so it reads the same as the START FREQUENCY.

13- To check the new setting depress START/RESET once more and go back to STEP 11.



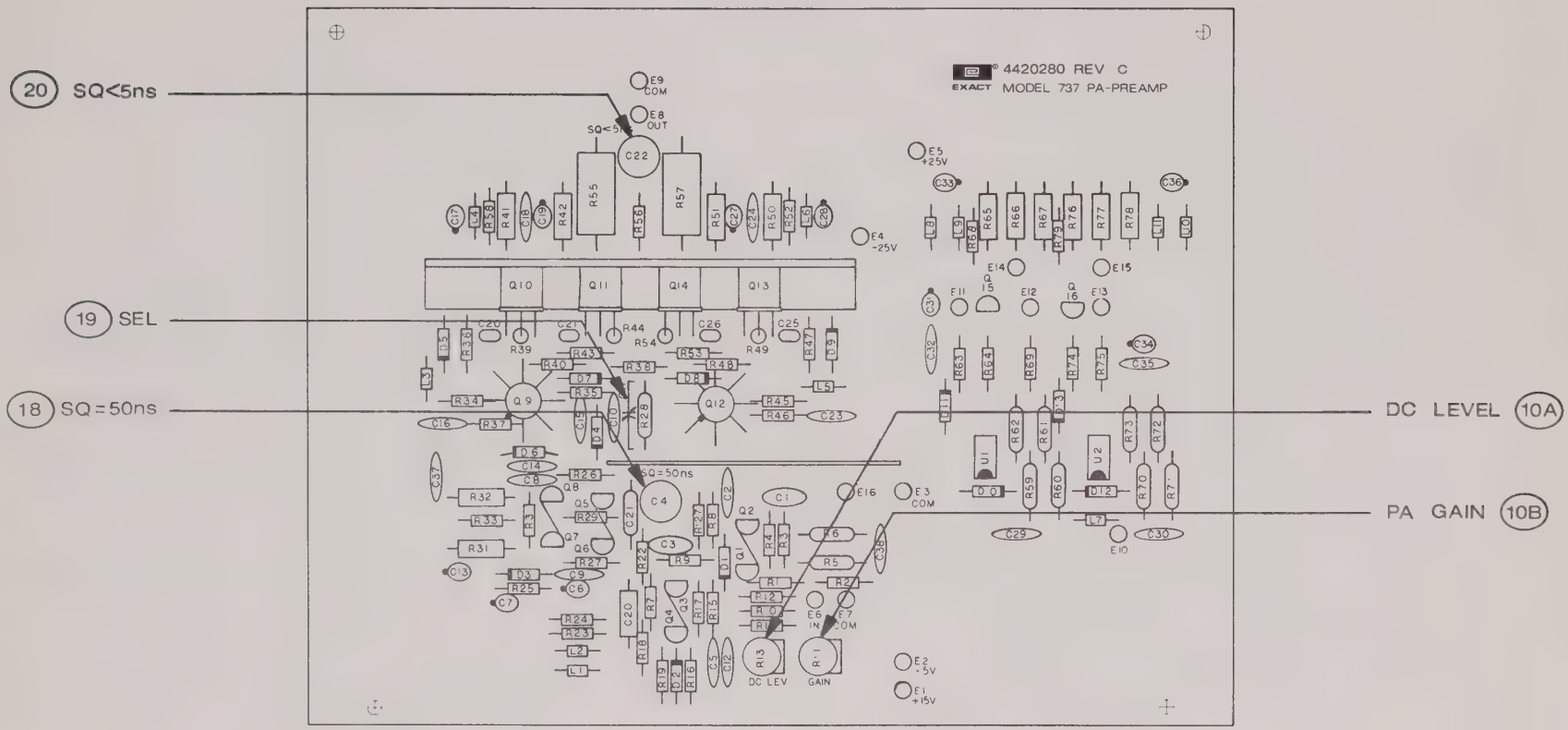
ADJ LOC DETAIL

IS/PS PCB A1



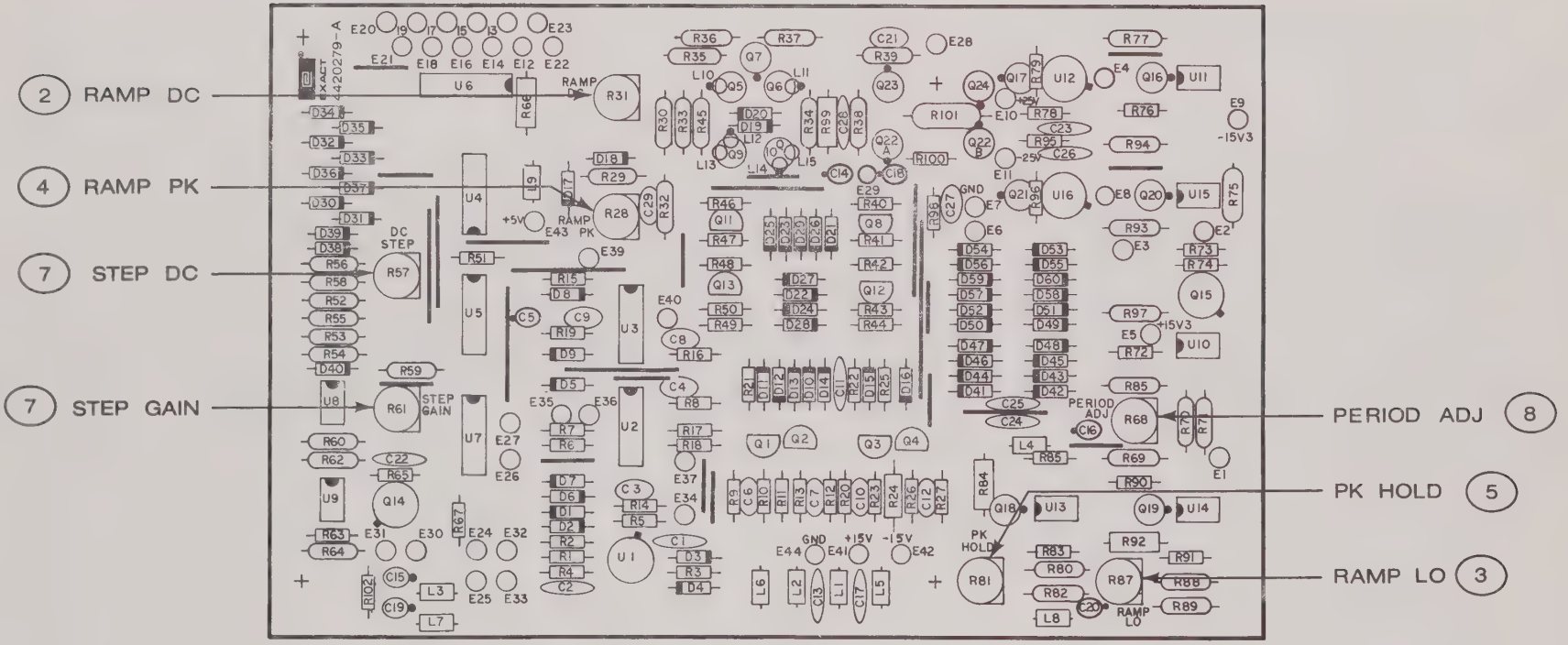
ADJ LOC DETAIL

MAIN LOOP BD-A2



ADJ LOC DETAIL

PA-PREAMP A3



ADJ LOC DETAIL

RAMP PCB A5

SECTION 6

PARTS LIST

CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00176	McCoy Electronics	Mount Holly Sprgs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00334	Humidail Co.	Colton, Calif
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Prod. Div	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00915	Northern Eng. Labs, Inc.	Burlington, Wis.
00853	Sangamo Electric Co. Orcill Div. (Caps)	Marion, Illinois
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif
01295	Texas Instruments, Inc. Transistor Prod. Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Inc.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Illinois
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. Amer.	Saugerties, N.Y.
02206	Cole Mfg. Co.	Palo Alto, Calif.
02660	Ampersil-Bory El. Corp.	Chicago, Illinois
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vacaline Company of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E., Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine and Tool Co.	Dayton, Ohio
03797	Ettemo Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Electric Co.	Hartford, Conn
04013	Taunus Corp.	Lambertville, N.J.
04022	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q, Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Div.	Burbank, Calif.
04354	Precision Paper Tube Co.	Chicago, Illinois
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prod., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola/Semiconductor Prod.	Phoenix, Arizona
04732	Filtron Co/Western Div.,	Culver City, Calif.
04773	Automatic Electric Co.,	Northlake, Illinois
04777	Automatic Elect. Sales Corp.	Northlake, Illinois
04796	Sequoia Wire/Cable Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Co.	Chicago, Illinois
05006	20th Century Plastics	Los Angeles, Calif.
05277	Westinghouse/Semicon. Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Eng. Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Illinois
05728	Tiffen Optical Co.	Roslyn Heights, L.I., N.Y.
05729	Metropolitan Telecomm. Corp Metro Cap Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc	Wakefield, Mass.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical	Rochester, N.Y.
06402	E.T.A. Products Amer.	Chicago, Illinois
06475	Western Devices, Inc.	Inglewood, Calif.
06540	Amatom Elect. Hardware Co.	New Rochelle, N.Y.
06555	Beede Electrical Inst. Co.	Penacook, N.H.
06751	U.S. Semicon Div. of Nuclear Corp/Amer.	Phoenix, Ariz.
06812	Torrington Mfg Co, West Div.	Van Nuys, Calif.
07068	Kaiser Electric Co.	Van Nuys, Calif.
07115	Corning Glass Works Electronics Comp. Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Bircher Corp.	Los Angeles, Calif.
07700	Technical Wire Products	Springfield, N.J.,
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Labs	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert, Co.	Pomona, Calif.
08351	Burgess Battery Co.	Niagara Falls, Ontario
08717	Sloan Company	Burbank, Calif.
08718	Cannon Elect Co, Phoenix Div.	Phoenix, Ariz.
08792	CBS Elect. Semiconductor Oper., Div. C.B.S., Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co	Houston, Texas
09145	Atahn Electronics	Sun Valley, Calif.
09250	Electra Assemblies, Inc.	Chicago, Illinois
09569	Mallory Battery Co/Canada Ltd.	Toronto, Ontario, Canada
09664	The Bristol Company	Waterbury, Conn.
10214	Gen. Trans. Western Corp.	Los Angeles, Calif
10411	TI-Tal, Inc.	Berkeley, Calif.
10597	Exact Electronics, Inc.	Hillsboro, Oreg.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Tel. of Calif., Inc.	S. Pasadena, Calif.
11312	Microwave Elect. Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	Gen'l Inst/Semiconductor Div	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.

Code No.	Manufacturer	Address
11970	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12697	Cramolat Mfg. Co.	Dover, N.H.
12855	Nippon Elect. Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermaltay	Haltx, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Semi-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif
14298	American Components Inc.	Conshohocken, Pa.
14655	Cornell Dubilier El. Corp.	So. Plainfield, N.J.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Elect., Co., Inc.	Brooklyn, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15909	The Daven Co.	Livingston, N.J.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16322	Computer Diode Corp.	Lodi, N.J.
16618	De Jur-Amsco Corp.	Long Island City, N.Y.
16758	Delco Radio, Division of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics, Inc.	Canoga Park, Calif.
17474	Tronex Company	Mountain View, Calif
18456	Radio Industries	Des Plaines, Illinois
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. Dupont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries Div. McGraw-Edison Co.	West Orange, N.J.
19701	Electro Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fonsteel Metallurgical Corp.	No. Chicago, Illinois
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24655	G.E. Lamp Div.	Nela Park, Cleveland, Ohio
24655	General Radio Co.	W. Concord, Mass.
25363	Gries Reproducer Corp.	New Rochelle, N.Y.
25964	Grobet File Co/America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
27480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	GE Receiving Tube Dept.	Owensboro, Ky.
33434	Lectrohm, Inc.	Chicago, Ill.
36196	Stanwyck Corp.	Hawkesbury, Ontario, Cd.
37942	P.R. Mallory and Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod.	Akron, Ohio
40920	Miniature Precision Bearings	Keene, N.H.
42190	Myter Co.	Chicago, Illinois
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Illinois
47904	Polaroid Corp.	Cambridge, Mass.
48670	Precision Thermometer/Inst.	Philadelphia, Pa.
49756	Raytheon Mfg. Co.	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
63743	Nerd Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Illinois
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson and Co., Inc.	S. Norwalk, Conn.
56137	Soaulding Fibre Co., Inc.	Tonowonda, N.Y.
56289	Sprague Electric Co.	N. Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas and Betts Co.	Elizabeth, N.J.
60741	Tripplett Electrical Inc.	Bluffon, Ohio
61775	Union Switch and Signal, Div. Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Osoosa, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	West Inst./Div. Daystron	Newark, N.J.
66295	Witek Manufacturing Co.	Chicago, Illinois
66266	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Manufacturing Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70345	Allmetal Screw Prod. Co, Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works	Chicago, Illinois
70563	Amperite Co., Inc.	New York, N.Y.
70903	Beldan Manufacturing Co.	Chicago, Illinois
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71280	Cambal Fastener Corp.	Paramus, N.J.,
71313	Allen D. Cardwell Elect. Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Illinois
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare and Co.	Chicago, Illinois
71590	Controls Div. Globe Union, Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Illinois
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Wks	Chicago, Illinois
71753	A. O. Smith Corp. Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Illinois
71984	Dow Corning Corp.	Midland, Mich.
72092	Eitel-McCullough, Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co, Inc.	Willimantic, Conn.
72207	Cato Coil, Co., Inc.	Providence, R.I.
72293	John E Fast and Company	Chicago, Illinois
72619	Daylight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp. Semiconductor Div.	Newark, N.J.
72705	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Illinois
72825	Hugh H. Eby, Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Illinois
72965	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H. M. Harper Co.	Chicago, Illinois
73138	Heliopot, Div. Beckman Instruments, Inc.	Fullerton, Calif.

Code No.	Manufacturer	Address
73293	Hughes Products Div. of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. No. American Philips Co., Inc.	Hicksville, N.Y.
73490	Beckman Hi-Stat Corp.	S. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73612	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Fearrel Screw Prod. Co.	Chicago, Illinois
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73846	Gosher Stamping and Tool	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74276	Signalite, Inc.	Neptune, N.J.,
74455	J. H. Winding and Sons	Winchester, Mass
74850	Industrial Condenser Corp.	Chicago, Illinois
74868	R.F. Prod. Div. of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Div. of Cinch Mfg. Corp.	Chicago, Illinois
75378	James Knights Co.	Sandwich, Illinois
75392	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Illinois
75915	Littlefuse, Inc.	Des Plaines, Illinois
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif
76433	Micamold Electronics Mfg. Corp	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Illinois
77068	Benaia Pacific Div. of Benaix Corp.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostron Instrument and Electronic Co.	S. Pasadena, Calif.
77250	Phaell Manufacturing Co.	Chicago, Illinois
77257	Philadelphia Steel and Wire Corporation	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine/Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.,
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof, Div. of Illinois Tool Works	Elgin, Illinois
78283	Signal Indicator Corp.,	New York, N.Y.
78290	Struthers-Dunn, Inc.	Pitman, N.J.,
78452	Thompson-Bremer and Co.	Chicago, Illinois
78471	Tilley Manufacturing Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79259	Wenco Mfg. Co.	Chicago, Illinois
79727	Continental-Wirt Elect. Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco, Div. of Sessions Clock Company	Morristown, N.J.
80120	Scientific Alloys Products	Elizabeth, N.J.,
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Assoc Any brand tube meeting EIA standards.	Washington D.C.
80207	Unimax Switch, Div. of W L Maxson Corp.	Wallingford, Conn
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Illinois
80294	Bourns Laboratories, Inc.	Riverside, Calif
80411	Acro, Div. of Robinshaw Fulton Controls Co.	Columbus, Ohio
80486	All Star Products, Inc.	Columbus, Ohio
80509	Avery Adhesive Label Corp.	Defiance, Ohio
80583	Hammerlund Co., Inc.	Monrovia, Calif.
80640	Stevens, Arnold Co., Inc.	New York, N.Y.
81030	International Instruments, Inc.	Boston, Mass.
81073	Graybill Co.	New Haven, Conn.
81095	Triad Transformer Corp.	LaGrange, Illinois
81312	Winchester Electronics Co.	Venice, Calif.
81349	Military Specifications	Norwalk, Conn.
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div. Industrial Tube Oper.	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Illinois
82142	Jeffers Electronics, Div. of Speer Carbon Co.	DuBois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Electron Tube Div.	Emporium, Pa.
82376	Astron Company	E. Newark, N.J.,
82389	Switchcraft, Inc.	Orange, Illinois
82647	Metals and Controls, Inc., Div. Texas Instruments, Spencer Products	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wisc.
82877	Ratron Mfg. Co., Inc.	Woodstock, N.Y.,
82893	Vector Electronic Co	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, California
83068	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing	Peterborough, N.H,
83125	Pyramid Electric Co.	Darlington, S.C,
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Springfield, N.J.,
83298	Bendix Corp/Red Bank Div.	Red Bank, N.J.,
83315	Hubbell Cord.	Mundelein, Illinois
83370	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Illinois
83501	Gowitt Wire and Cable Co., Div. Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.,

Code No.	Manufacturer	Address
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A.J. Gleasner Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Nebr.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Co.	Boonton, N.J.,
85474	R.M. Brocamonte and Co.	San Francisco, Calif.
85660	Kailed Kards, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Illinois
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.,
87716	Phileo Corp. (Lansing Div.)	Lansing, Pa.
87743	Western Fibrous Glass Products Co.	San Francisco
87764	Van Waters and Rogers, Inc.	Seattle, Wash.
87930	Tomer Mfg. Co.	Providence, R.I.
88143	Cutler-Hammer, Inc.	Lincoln, Illinois
88170	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
8823	Graybar Electric Co.	Oakland, Calif.
87462	Walden Kohinoor, Inc.	Commidge, Mass.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baker Co.	Chicago, Illinois
89665	United Transformer Co.	Chicago, Illinois
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.,
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial and Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Illinois
91506	Augat Brothers, Inc.	Attleboro, Mass.
91637	Dale Electronics Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia
91737	Gremar Mfg Co., Inc.	Wakefield Mass.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Illinois
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92196	Universal Metal Prod., Inc.	Bassett Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod, Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93768	Howard J. Smith, Inc.	Port Monmouth, N.J.
93929	G.V. Controls	Livingston, N.J.,
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94137	General Cable Corp.	Bayonne, N.J.,
94144	Raytheon Mfg. Co., Industrial Comp. Div. Rec. Tube Div.	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div, Calif. St. Plt	Newton, Mass.
94148	Scientific Radio Products	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.,
94197	Curtiss-Wright Corp., Electronics Div.	E. Paterson, N.J.,
94222	Southco, Div. S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod., Div. Model Engineering and Mfg. Co.	Chicago, Illinois
94330	Wire Cloth Products, Inc.	Chicago, Illinois
94682	Worcester Pressed Alum. Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95764	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.,
95354	Methode Mfg. Co.	Chicago, Illinois
95712	Dage Electric Co., Inc.	Franklin, Ind.
95987	Weckesser Co.	Chicago, Illinois
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner, Div. Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif
96330	Carlton Screw Co.	Chicago, Illinois
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J
97539	Automatic and Precision Mfg.	Yonkers, N.Y,
97966	CBS Electronics Div. C.B.S., Inc.	Danvers, Mass.
97979	Resin Resistor Corp.	Yonkers, N.Y,
98041	Axel Brothers, Inc.	Jamaica, N.Y.
98159	Rubber Tech, Inc.	Gardena, Calif.
98220	Francis L. Mealey	Pasadena, Calif.
98278	Microdot, Inc.	S. Pasadena, Calif.
98291	Seaseota Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
93821	North Hills Electric Co.	Mineola, N.Y.
98975	Clevite Transistor Prod. Div Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Div., Controls Co. of America	El Segundo, Calif
[illegible]	Delevan Electronics Corp.	E. Aurora, N.Y.
99048	Wilco Corporation	Indianapolis, Ind.
99934	Fenbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div of Hoffman Electronics Corp.	Evanston, Illinois
99957	Technology Instrument Corp. of California	Newbury Park, Calif.

PART	DESCRIPTION	EXACT NO	MFG
A1	POWER SUPPLY & CURRENT SOURCES PCB ASSY		
A1 A000	IS/PS PCB	4420276.	10597.
A1 C001	CAPACITOR, 2500MFD 35V	2900034.	853.
A1 C002	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C003	CAPACITOR, 2500MFD 35V	2900034.	853.
A1 C004	CAPACITOR, 2500MFD 35V	2900034.	853.
A1 C005	CAPACITOR, 1500 PF DISC	2830012.	91418.
A1 C006	CAPACITOR, 1500 PF DISC	2830012.	91418.
A1 C007	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C008	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C009	CAPACITOR, 2500MFD 35V	2900034.	853.
A1 C010	CAPACITOR, 2500MFD 35V	2900034.	853.
A1 C011	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C012	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C013	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C014	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C015	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C016	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C017	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C018	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C019	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C020	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C021	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C022	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C023	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C024	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C025	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C026	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C027	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C028	CAPACITOR, 1000 PF DISC	2830000	91418.
A1 C029	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C030	CAPACITOR, 1000 PF DISC	2830000	91418.
A1 C031	CAPACITOR, 100PF MICA	2810537.	853.
A1 C032	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C033	CAPACITOR, 100PF MICA	2810537.	853.
A1 C034	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C035	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C036	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 D001	TO		
A1 D015	DIODE, 1N4001	1524001.	1295.
A1 D016	DIODE, 1N914	1520914.	7910.
A1 D017	DIODE, 1N914	1520914.	7910.
A1 D018	TO		
A1 D020	DIODE, 1N914	1520914.	7910.
A1 L001	TO		
A1 L004	CHOKE 2 TURN BEAD	1140029.	10597.
A1 Q001	TRANSISTOR, EN2484	1562484.	7263.
A1 Q002	TRANSISTOR, 2N2905	1562905.	1295.
A1 Q003	TRANSISTOR, EN2484	1562484.	7263.
A1 Q004	TRANSISTOR, 2N4250	1564250.	7263.
A1 Q005	TRANSISTOR, 2N4258	1564258.	7263.
A1 Q006	TRANSISTOR, 2N4250	1564250.	7263.
A1 Q007	TRANSISTOR, 2N3563	1563563.	4713.
A1 Q008	TRANSISTOR, EN2484	1562484.	7263.
A1 Q009	TRANSISTOR, MPS3563	1563563.	4713.
A1 Q010	TRANSISTOR, MPS3563	1563563.	4713.
A1 Q011	TRANSISTOR, 2N4250	1564250.	7263.
A1 Q012	TRANSISTOR, EN2484	1562484.	7263.
A1 Q013	TRANSISTOR, 2N4250	1564250.	7263.
A1 Q014	TRANSISTOR, 2N2916	1562916.	4713.
A1 Q015	TRANSISTOR, 2N4250	1564250.	7263.
A1 R001	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A1 R002	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
A1 R003	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
A1 R004	RESISTOR, 75 OHM 1/4W 5% CARBON	3070750.	1121.
A1 R005	RESISTOR, 0.56 OHM 2W WIREWOUN	3080005.	75042.
A1 R006	RESISTOR, 75 OHM 1/4W 5% CARBON	3070750.	1121.
A1 R007	RESISTOR, 0.56 OHM 2W WIREWOUN	3080005.	75042.
A1 R008	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743.	7115.
A1 R009	POTENTIOMETER, 50K OHM TRIM	3110350.	71450.
A1 R010	RESISTOR,20000 OHM 1/4W 1% METAL FILM	3132002.	7115.
A1 R011	POTENTIOMETER, 50K OHM TRIM	3110350.	71450.
A1 R012	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103.	1121.
A1 R013	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103.	1121.
A1 R014	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
A1 R015	RESISTOR, 8200 OHM 1/4W 5% CAREON	3070822.	1121.
A1 R016	POTENTIOMETER, 2K OHM TRIM	3110348.	71450.
A1 R017	RESISTOR, 9100 OHM 1/4W 5% CAREON	3070912.	1121.
A1 R018	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
A1 R019	RESISTOR, 9100 OHM 1/4W 5% CARBON	3070912.	1121.
A1 R020	POTENTIOMETER, 2K OHM TRIM	3110348.	71450.
A1 R021	RESISTOR, 8200 OHM 1/4W 5% CARBON	3070822.	1121.
A1 R022	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
A1 R023	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
A1 R024	RESISTOR, 56K OHM 1/4W 5% CARBON	3070563.	1121.
A1 R025	POTENTIOMETER, 10K OHM TRIM	3110349.	71450.
A1 R026	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512.	1121.
A1 R027	RESISTOR, 620 OHM 1/4W 5% CARBON	3070621.	1121.
A1 R028	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333.	1121.
A1 R029	RESISTOR, 110K OHM 1/4W 1% METAL FILM	3131103.	7115.
A1 R030	RESISTOR, 49.9K OHM 1/4W 1% METAL FILM	3134992.	7115.
A1 R031	RESISTOR,10000K OHM 1/2W 1% DEP. CARBON	3091005.	75042.
A1 R032	POTENTIOMETER, 10K OHM TRIM	3110349.	71450.
A1 R033	RESISTOR, 49.9K OHM 1/4W 1% METAL FILM	3134992.	7115.
A1 R034	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333.	1121.
A1 R035	POTENTIOMETER, 20K TRIM	3110355.	71450
A1 R036	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333.	1121.
A1 R037	RESISTOR, 24K OHM 1/4W 5% CARBON	3070243.	1121.
A1 R038	RESISTOR, 820 OHM 1/4W 5% CARBON	3070821.	1121.
A1 R039	RESISTOR, 1000 OHM MATCHED PAIR	3121001.	10597.
A1 R040	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A1 R041	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242.	1121.
A1 R042	POTENTIOMETER, 10K OHM TRIM	3110349.	71450.
A1 R043	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A1 R044	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332.	1121.
A1 R045	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332.	1121.
A1 R046	RESISTOR, 150 OHM 1/4W 1% METAL FILM	3131500.	7115.
A1 R047	RESISTOR, 374 OHM 1/4W 1% METAL FILM	3133740.	7115.
A1 R048	RESISTOR, 1000 OHM MATCHED PAIR	3121001.	10597.
A1 R049	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001.	7115.
A1 R050	POTENTIOMETER, 10K OHM TRIM	3110349.	71450.
A1 R051	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A1 R052	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242.	1121.
A1 R053	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332.	1121.
A1 R054	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332.	1121.
A1 R055	RESISTOR, 374 OHM 1/4W 1% METAL FILM	3133740.	7115.
A1 R056	RESISTOR, 150 OHM 1/4W 1% METAL FILM	3131500.	7115.
A1 R057	RESISTOR, 93.1 OHM 1/4W 1% METAL FILM	3130931.	7115.
A1 R058	RESISTOR, 187 OHM 1/4W 1% METAL FILM	3131870.	7115.
A1 R059	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A1 R060	RESISTOR, 1.0 OHM 1/2W 5% CARBON	3010010.	1121.
A1 R061	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000.	7115.
A1 R062	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001.	7115.
A1 R063	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
A1 R064	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003.	7115.
A1 R065	RESISTOR, 1000K OHM 1/4W 1% METAL FILM	3131004.	7115.
A1 R066	RESISTOR,10000K OHM 1/2W 1% DEP. CARBON	3091005.	75042.
A1 R067	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150.	1121.
A1 R068	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A1 R069	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A1 R070	POTENTIOMETER, 2K OHM TRIM	3110348.	71450.
A1 R071	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202.	1121.
A1 R072	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A1 R073	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A1 R074	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A1 R075	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A1 R076	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A1 R077	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512.	1121.
A1 R078	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A1 R079	TO		
A1 R081	RESISTOR, 270 OHM 1/4W 5% CARBON	3070271.	1121.
A1 R082	TO		
A1 R084	RESISTOR, 270 OHM 1/4W 5% CARBON	3070271.	1121.
A1 R085	TO		
A1 R086	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471.	1121.
A1 R089	RESISTOR, 27K OHM 1/4W 5% CARBON	3070273.	1121.
A1 R090	RESISTOR, 12K OHM 1/4W 5% CARBON	3070123.	1121.
A1 R091	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
A1 R092	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A1 R093	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220.	1121.
A1 R094	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A1 R095	RESISTOR, 560 OHM 1/4W 5% CARBON	3070561.	1121.
A1 R096	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220.	1121.
A1 R097	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A1 R098	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
A1 R099	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A1 R100	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103.	1121.
A1 R101	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A1 R102	RESISTOR, 24K OHM 1/4W 5% CARBON	3070243.	1121.
A1 R103	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A1 R104	POTENTIOMETER, 5K OHM TRIM	3110354.	71450.
A1 R105	RESISTOR, 8200 OHM 1/4W 5% CARBON	3070822.	1121.
A1 R106	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A1 R107	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211.	7115.
A1 R108	RESISTOR, 3500K OHM 1/2W 1% DEP. CARBON	3093504.	75042.
A1 R109	RESISTOR, 71.5K OHM 1/4W 1% METAL FILM	3137152.	7115.
A1 R110	POTENTIOMETER, 200K OHM TRIM	3110351.	71450.
A1 R111	RESISTOR,20000 OHM 1/4W 1% METAL FILM	3132002.	7115.
A1 R112	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203.	1121.
A1 R113	POTENTIOMETER, 50K OHM TRIM	3110350.	71450.
A1 R114	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991.	7115.
A1 R115	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991.	7115.
A1 R116	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242.	1121.
A1 R117	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103.	1121.
A1 R118	RESISTOR, 24K OHM 1/4W 5% CARBON	3070243.	1121.
A1 R119	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A1 R120	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471.	1121.
A1 R121	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471.	1121.
A1 R122	RESISTOR,10000K OHM 1/2W 1% DEP. CARBON	3091005.	75042.
A1 R123	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220.	1121.
A1 R124	POTENTIOMETER, 100 OHM TRIM	3110345.	71450.
A1 RT01	RESISTOR, 1000 OHM THERMISTOR	3171001.	1295.
A1 U001	INTEGRATED CIRCUIT,SG4501	1584502.	10597.
A1 U002	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A1 U003	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A1 U004	INTEGRATED CIRCUIT, 4136 QUAD O	1584136.	01295.
A1 U005	OP AMP, CA3140S	1583140.	2735.
A1 U006	OP AMP, CA3140S	1583140.	2735.
A1 U007	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A1 U008	OP AMP, CA3140S	1583140.	2735.
A1 U009	INTEGRATED CIRCUIT, SN7403N	1587403.	1295.
A1 U010	INTEGRATED CIRCUIT, 555 TIMER	1580555.	4713.
A1 U011	INTEGRATED CIRCUIT, 4136 QUAD O	1584136.	01295.
A1 U012	INTEGRATED CIRCUIT, LM312	1580312.	10597.
A1 U013	INTEGRATED CIRCUIT, LM312	1580312.	10597.
A1 U014	INTEGRATED CIRCUIT, SN7402N	1580021.	1295.
A2	LOOP PCB ASSY		
A2 A000	MAIN LOOP PCB	4420277.	10597
A2 C001	CAPACITOR, 8-50PF TRIM	2810022.	72982.
A2 C002	CAPACITOR, 68PF MICA	2810523.	853.
A2 C003	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C004	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C005	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C006	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C007	CAPACITOR, MICA 2PF	2810542.	853.
A2 C008	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C009	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C010	CAPACITOR, 22PF MICA	2810530.	853.
A2 C011	CAPACITOR, 5.5-18PF TRIM	2810011.	72982.
A2 C012	CAPACITOR, TIMING SET	2950002.	10597.
A2 C015	CAPACITOR, 5.5-18PF TRIM	2810011.	72982.
A2 C016	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C017	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C018	CAPACITOR, 100PF MICA	2810537.	853.
A2 C019	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C020	CAPACITOR, 100PF MICA	2810537.	853.
A2 C021	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C022	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C023	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C024	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C025	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C026	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C027	CAPACITOR, 220PF MICA	2810555.	853.
A2 C028	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C029	TO		
A2 C031	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C032	CAPACITOR, 100PF MICA	2810537.	853.

PART	DESCRIPTION	EXACT NO	MFG
A2 C033	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C034	CAPACITOR, 220PF MICA	2810555.	853.
A2 C035	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C036	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C037	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C038	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C039	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C040	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C041	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C042	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C043	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C044	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C045	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C046	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C047	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C048	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C049	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C050	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C051	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C052	CAPACITOR, 47PF MICA	2810532.	853.
A2 C054	CAPACITOR, 39PF MICA	2810531.	853.
A2 C055	CAPACITOR, 39PF MICA	2810531.	853.
A2 C057	CAPACITOR, 47PF MICA	2810532.	853.
A2 C058	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C059	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C060	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C061	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C062	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C063	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C064	CAPACITOR, SELECTED VALUE		
A2 C065	CAPACITOR, SELECTED VALUE		
A2 D001	TO		
A2 D006	DIODE, HOT CARRIER	1522811.	28480.
A2 D013	TO		
A2 D020	DIODE, HOT CARRIER	1522811.	28480.
A2 D021	DIODE, 1N756	1520756.	1295.
A2 D022	DIODE, 1N753A	1520753.	1295.
A2 D023	DIODE, 1N751A	1520751.	75042.
A2 D024	TO		
A2 D027	DIODE, 1N914	1520914.	7910.
A2 D028	DIODE, 1N753A	1520753.	1295.
A2 D029	DIODE, 1N914	1520914.	7910.
A2 D030	DIODE, 1N914	1520914.	7910.
A2 D031	TO		
A2 D036	DIODE, 1N753A	1520753.	1295.
A2 D037	DIODE, 1N914	1520914.	7910.
A2 L001	TO		
A2 L004	BEAD, FERRITE G303	1140034.	1121.
A2 L005	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L007	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L008	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L009	BEAD, FERRITE G303	1140034.	1121.
A2 L010	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L011	BEAD, FERRITE G303	1140034.	1121.
A2 L012	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L013	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L014	CHOKE 6 TURN BEAD	1140032.	10597.
A2 L015	TO		
A2 L017	BEAD, FERRITE G303	1140034.	1121.
A2 L018	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L019	BEAD, FERRITE G303	1140034.	1121.
A2 L020	BEAD, FERRITE G303	1140034.	1121.
A2 L021	CHOKE 6 TURN BEAD	1140032.	10597.
A2 L022	BEAD, FERRITE G303	1140034.	1121.
A2 L023	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L024	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L025	TO		
A2 L028	BEAD, FERRITE G303	1140034.	1121.
A2 L029	CHOKE 6 TURN BEAD	1140032.	10597.
A2 L030	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L031	TO		
A2 L034	BEAD, FERRITE G303	1140034.	1121.
A2 L035	CHOKE 6 TURN BEAD	1140032.	10597.
A2 L036	CHOKE 3 TURN BEAD	1140030.	10597.
A2 L037	TO		
A2 L041	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L042	TO		
A2 L043	BEAD, FERRITE G303	1140034.	1121.
A2 Q001	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q002	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q003	TRANSISTOR, TIS87	1560087.	1295.
A2 Q004	TRANSISTOR, TIS87	1560087.	1295.
A2 Q005	TRANSISTOR, 2N2219	1562219.	1295.
A2 Q006	TRANSISTOR, BFQ23	1560023.	73445.
A2 Q007	TRANSISTOR, BFR91	1560091.	73445.
A2 Q008	TRANSISTOR, 2N5912	1565912.	4713.
A2 Q008	TRANSISTOR, DN991	1560991.	10597.
A2 Q009	TRANSISTOR, BFR91	1560091.	73445.
A2 Q010	TRANSISTOR, BFQ23	1560023.	73445.
A2 Q011	TRANSISTOR, EN2484	1562484.	7263.
A2 Q012	TRANSISTOR, MPS3563	1563563.	4713.
A2 Q013	TRANSISTOR, MPS3563	1563563.	4713.
A2 Q014	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q015	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q016	TRANSISTOR, MPS3563	1563563.	4713.
A2 Q017	TRANSISTOR, MPS3563	1563563.	4713.
A2 Q018	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q019	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q020	TRANSISTOR, MPS3563	1563563.	4713.
A2 Q021	TRANSISTOR, MPS3563	1563563.	4713.
A2 Q022	TO		
A2 Q024	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q025	TRANSISTOR, 2N5179	1565179.	4713.
A2 Q026	TRANSISTOR, 2N5179	1565179.	4713.
A2 Q027	TRANSISTOR, EN2484	1562484.	7263.
A2 Q028	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q029	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q030	TRANSISTOR, 2N5179	1565179.	4713.
A2 Q031	TRANSISTOR, 2N5179	1565179.	4713.
A2 Q032	TRANSISTOR, EN2484	1562484.	7263.
A2 Q033	TRANSISTORS, MATCHED MPS3563	1573563.	10597.
A2 Q034	TRANSISTORS, MATCHED 2N4258	1574258.	10597.
A2 Q035	TRANSISTORS, MATCHED MPS3563	1573563.	10597.
A2 Q036	TRANSISTORS, MATCHED 2N4258	1574258.	10597.
A2 Q037	TRANSISTORS, MATCHED MPS3563	1573563.	10597.
A2 Q038	TRANSISTORS, MATCHED 2N4258	1574258.	10597.

PART	DESCRIPTION	EXACT NO	MFG
A2 Q039	TRANSISTOR, 2N4250	1564250.	7263.
A2 QX01	HEAT CLIP	2000109.	13103.
A2 QX02	TO		
A2 R001	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A2 R002	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R003	RESISTOR, 221 OHM 1/4W 1% METAL FILM	3132210.	7115.
A2 R004	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R005	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R006	RESISTOR, 187 OHM 1/4W 1% METAL FILM	3131870.	7115.
A2 R007	RESISTOR, 82.5 OHM 1/4W 1% METAL FILM	3130825.	7115.
A2 R008	RESISTOR, 562 OHM 1/4W 1% METAL FILM	3135620.	7115.
A2 R009	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
A2 R010	RESISTOR, 2740 OHM 1/4W 1% METAL FILM	3132741.	7115.
A2 R011	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R012	RESISTOR, 2150 OHM 1/4W 1% METAL FILM	3132151.	7115.
A2 R013	RESISTOR, 2150 OHM 1/4W 1% METAL FILM	3132151.	7115.
A2 R014	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R015	RESISTOR, 820 OHM 1/2W 5% CARBON	3010821	1121.
A2 R017	RESISTOR, 12K OHM 1/4W 5% CARBON	3070123.	1121.
A2 R018	RESISTOR, 12K OHM 1/4W 5% CARBON	3070123.	1121.
A2 R020	RESISTOR, 6800 OHM 1/4W 5% CARBON	3070682.	1121.
A2 R021	RESISTOR, 6800 OHM 1/4W 5% CARBON	3070682.	1121.
A2 R022	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A2 R023	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A2 R024	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A2 R025	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R026	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R027	RESISTOR, 560 OHM 1/2W 5% CARBON	3010561.	1121.
A2 R028	RESISTOR, 820 OHM 1/4W 5% CARBON	3070821.	1121.
A2 R029	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R030	POTENTIOMETER, 5K OHM TRIM	3110354.	71450.
A2 R031	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122.	1121.
A2 R032	RESISTOR, 91 OHM 1/4W 5% CARBON	3070910.	1121.
A2 R033	RESISTOR, 91 OHM 1/4W 5% CARBON	3070910.	1121.
A2 R034	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R035	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499.	7115.
A2 R036	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R037	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R038	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901.	7115.
A2 R039	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499.	7115.
A2 R040	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R041	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R042	RESISTOR, 750 OHM 1/4W 5% CARBON	3070751.	1121.
A2 R043	RESISTOR, 330 OHM 1/4W 5% CARBON	3070331.	1121.
A2 R044	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121.	1121.
A2 R045	RESISTOR, 510 OHM 1/4W 5% CARBON	3070511.	1121.
A2 R046	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121.	1121.
A2 R047	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121.	1121.
A2 R048	RESISTOR, 330 OHM 1/4W 5% CARBON	3070331.	1121.
A2 R049	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A2 R050	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A2 R051	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R052	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301.	1121.
A2 R053	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R054	RESISTOR, 5600 OHM 1/4W 5% CARBON	3070562.	1121.
A2 R055	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R056	RESISTOR, 910 OHM 1/4W 5% CARBON	3070911.	1121.
A2 R057	RESISTOR, 820K OHM 1/4W 5% CARBON	3070824.	1121.
A2 R059	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202.	1121.
A2 R060	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R061	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R062	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R063	TO		
A2 R065	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A2 R066	RESISTOR, 180 OHM 1/4W 5% CARBON	3070181.	1121.
A2 R067	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A2 R068	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R069	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R070	RESISTOR, 430 OHM 1/2W 5% CARBON	3010431.	1121.
A2 R071	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R072	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R073	RESISTOR, 270 OHM 1/4W 5% CARBON	3070271.	1121.
A2 R074	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R075	RESISTOR, 1100 OHM 1/4W 5% CARBON	3070112.	1121.
A2 R076	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A2 R077	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R078	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R079	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203.	1121.
A2 R080	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203.	1121.
A2 R081	TO		
A2 R083	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A2 R084	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R085	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R086	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R087	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R088	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R089	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R090	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R091	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R092	POTENTIOMETER, 100 OHM TRIM	3110345.	71450.
A2 R093	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R094	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R095	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R096	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R097	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R098	POTENTIOMETER, 100 OHM TRIM	3110345.	71450.
A2 R099	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R100	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R101	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R102	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R103	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R104	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R105	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R106	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R107	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R108	RESISTOR, 560 OHM 1/2W 5% CARBON	3010561.	1121.
A2 R109	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R110	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R111	RESISTOR, 39.2 OHM 1/4W 1% METAL FILM	3130392.	7115.
A2 R112	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122.	1121.
A2 R113	RESISTOR, 39.2 OHM 1/4W 1% METAL FILM	3130392.	7115.
A2 R114	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R115	POTENTIOMETER, 2K OHM TRIM	3110348.	71450.
A2 R116	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332.	1121.
A2 R117	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332.	1121.
A2 R118	POTENTIOMETER, 2K OHM TRIM	3110348.	71450.
A2 R119	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.

PART	DESCRIPTION	EXACT NO	MFG
A2 R120	RESISTOR, 39.2 OHM 1/4W 1% METAL FILM	3130392.	7115.
A2 R121	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122.	1121.
A2 R122	RESISTOR, 39.2 OHM 1/4W 1% METAL FILM	3130392.	7115.
A2 R123	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R124	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R125	RESISTOR, 32.4 OHM 1/4W 1% METAL FILM	3130324.	7115.
A2 R126	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A2 R127	RESISTOR, 32.4 OHM 1/4W 1% METAL FILM	3130324.	7115.
A2 R128	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R129	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R130	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R131	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R132	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R133	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R134	RESISTOR, 32.4 OHM 1/4W 1% METAL FILM	3130324.	7115.
A2 R135	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A2 R136	RESISTOR, 32.4 OHM 1/4W 1% METAL FILM	3130324.	7115.
A2 R137	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R138	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R139	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R140	RESISTOR, 37.4 OHM 1/4W 1% METAL FILM	3130374.	7115.
A2 R141	RESISTOR, 560 OHM 1/4W 5% CARBON	3070561.	1121.
A2 R142	RESISTOR, 37.4 OHM 1/4W 1% METAL FILM	3130374.	7115.
A2 R143	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R144	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R145	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R146	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R147	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R148	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R149	RESISTOR, 37.4 OHM 1/4W 1% METAL FILM	3130374.	7115.
A2 R150	RESISTOR, 560 OHM 1/4W 5% CARBON	3070561.	1121.
A2 R151	RESISTOR, 37.4 OHM 1/4W 1% METAL FILM	3130374.	7115.
A2 R152	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R153	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R154	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302.	1121.
A2 R155	RESISTOR, 91 OHM 1/4W 5% CARBON	3070910.	1121.
A2 R156	POTENTIOMETER, 5K OHM TRIM	3110354.	71450.
A2 R157	RESISTOR, 2200 OHM 1/4W 5% CAREON	3070222.	1121.
A2 R158	RESISTOR, 3600 OHM 1/4W 5% CARBON	3070362.	1121.
A2 R159	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R160	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R161	RESISTOR, 270 OHM 1/4W 5% CARBON	3070271.	1121.
A2 R162	RESISTOR, 220 OHM 1/4W 5% CARBON	3070220.	1121.
A2 U001	IC, MC10102	1580102.	4713.
A2 U002	INTEGRATED CIRCUIT,SN74S140	1580140.	1295.
A2 U003	IC, MC10102	1580102.	4713.
A2 U004	INTEGRATED CIRCUIT, MC10131P	1580131.	4713.
A2 U005	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A2 U006	INTEGRATED CIRCUIT, MC10105P	1580105.	4713.
A2 ZZZZ	SWITCH WAFER, FUNCTION	2600420.	10597.
A2 ZZZZ	SWITCH WAFER, RANGE	2600421.	10597.

A3 PA & PREAMP PCB ASSY

A3 A000	PA/PRE AMP PCB	4420280.	10597.
A3 C001	CAPACITOR, 5PF MICA	2810501.	853.
A3 C002	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A3 C003	CAPACITOR, 3PF MICA	2810500.	853.
A3 C004	CAPACITOR, 8-50PF TRIM	2810022.	72982.
A3 C005	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A3 C006	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C007	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C008	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A3 C009	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A3 C010	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A3 C011	TO		
A3 C012	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A3 C013	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C014	TO		
A3 C016	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A3 C017	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C018	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A3 C019	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C020	CAPACITOR, 0.047 UF	2830013.	15450.
A3 C021	CAPACITOR, 0.047 UF	2830013.	15450.
A3 C022	CAPACITOR, 5.5-18PF TRIM	2810011.	72982.
A3 C023	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A3 C024	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A3 C025	CAPACITOR, 0.047 UF	2830013.	15450.
A3 C026	CAPACITOR, 0.047 UF	2830013.	15450.
A3 C027	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C028	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C029	CAPACITOR, 5000 PF DISC	2830011.	91418.
A3 C030	CAPACITOR, 5000 PF DISC	2830011.	91418.
A3 C031	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C032	CAPACITOR, 1000 PF DISC	2830000.	91418.
A3 C033	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C034	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C035	CAPACITOR, 1000 PF DISC	2830000.	91418.
A3 C036	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C037	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A3 C038	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A3 D001	DIODE, 1N758	1520758.	1295.
A3 D002	DIODE, 1N751A	1520751.	75042.
A3 D003	DIODE, 1N756	1520756.	1295.
A3 D004	DIODE, 1N4747 20V ZENER	1524747.	4713.
A3 D005	DIODE, 1N914	1520914.	7910.
A3 D006	DIODE, 1N4744 15V ZENER	1524744.	4713.
A3 D007	TO		
A3 D009	DIODE, 1N914	1520914.	7910.
A3 D010	DIODE, 1N914	1520914.	7910.
A3 D011	DIODE, 1N758	1520758.	1295.
A3 D012	DIODE, 1N914	1520914.	7910.
A3 D013	DIODE, 1N758	1520758.	1295.
A3 L001	CHOKE 3 TURN BEAD	1140030.	10597.
A3 L002	CHOKE 3 TURN BEAD	1140030.	10597.
A3 L003	CHOKE 4 TURN BEAD	1140052.	10597.
A3 L004	TO		
A3 L006	CHOKE 3 TURN BEAD	1140030.	10597.
A3 L007	CHOKE 6 TURN BEAD	1140032.	10597.
A3 L008	TO		
A3 L011	CHOKE 2 TURN BEAD	1140029.	10597.
A3 Q001	TRANSISTOR, 2N5179	1565179.	4713.
A3 Q002	TRANSISTOR, 2N5179	1565179.	4713.
A3 Q003	TO		
A3 Q006	TRANSISTOR, 2N4258	1564258.	7263.
A3 Q007	TRANSISTOR, 2N5179	1565179.	4713.
A3 Q008	TRANSISTOR, 2N5179	1565179.	4713.
A3 Q009	TRANSISTOR, 2N5583	1565583.	4713.
A3 Q010	TO		
A3 Q012	TRANSISTOR, 2N5943	1565943.	4713.
A3 Q013	TRANSISTOR, 2N5583	1565583.	4713.
A3 Q014	TRANSISTOR, 2N5583	1565583.	4713.
A3 Q015	TRANSISTOR, 2N4250	1564250.	7263.
A3 Q016	TRANSISTOR, EN2484	1562484.	7263.
A3 R001	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470.	1121.
A3 R002	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A3 R003	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A3 R004	RESISTOR, 510 OHM 1/4W 5% CARBON	3070511.	1121.
A3 R005	RESISTOR, 2870 OHM 1/4W 1% METAL FILM	3132871.	7115.
A3 R006	RESISTOR, 2870 OHM 1/4W 1% METAL FILM	3132871.	7115.
A3 R007	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202.	1121.
A3 R008	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470.	1121.
A3 R009	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A3 R010	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471.	1121.
A3 R011	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A3 R012	RESISTOR, 27K OHM 1/4W 5% CARBON	3070273.	1121.
A3 R013	POTENTIOMETER, 20K TRIM	3110355.	71450.
A3 R014	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R015	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A3 R016	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A3 R017	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047.	1121.
A3 R018	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202.	1121.
A3 R019	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A3 R020	RESISTOR, 1000 OHM 1/2W 5% CARBON	3010102.	1121.
A3 R021	RESISTOR, 121 OHM 1/4W 1% METAL FILM	3131210.	7115.
A3 R022	RESISTOR, 510 OHM 1/4W 5% CARBON	3070511.	1121.
A3 R023	TO		
A3 R025	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150.	1121.
A3 R026	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047.	1121.
A3 R027	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047.	1121.
A3 R028	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001.	7115.
A3 R029	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470.	1121.
A3 R030	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A3 R031	RESISTOR, 820 OHM 1/2W 5% CARBON	3010821.	1121.
A3 R032	RESISTOR, 820 OHM 1/2W 5% CARBON	3010821.	1121.
A3 R033	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470.	1121.
A3 R034	RESISTOR, 160 OHM 1/4W 5% CARBON	3070161.	1121.
A3 R035	RESISTOR, 27K OHM 1/4W 5% CARBON	3070273.	1121.
A3 R036	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150.	1121.
A3 R037	RESISTOR, 68 OHM 1/4W 5% CARBON	3070680.	1121.
A3 R038	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R039	RESISTOR, 33 OHM 1/4W 5% CARBON	3070330.	1121.
A3 R040	RESISTOR, 33 OHM 1/4W 5% CARBON	3070330.	1121.
A3 R041	RESISTOR, 51 OHM 1/2W 5% CARBON	3010510.	1121.
A3 R042	RESISTOR, 51 OHM 1/2W 5% CARBON	3010510.	1121.
A3 R043	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R044	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R045	RESISTOR, 160 OHM 1/4W 5% CARBON	3070161.	1121.
A3 R046	RESISTOR, 68 OHM 1/4W 5% CARBON	3070680.	1121.
A3 R047	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150.	1121.
A3 R048	RESISTOR, 33 OHM 1/4W 5% CARBON	3070330.	1121.
A3 R049	RESISTOR, 33 OHM 1/4W 5% CARBON	3070330.	1121.
A3 R050	RESISTOR, 51 OHM 1/2W 5% CARBON	3010510.	1121.
A3 R051	RESISTOR, 51 OHM 1/2W 5% CARBON	3010510.	1121.
A3 R052	RESISTOR, 240 OHM 1/4W 5% CARBON	3070241.	1121.
A3 R053	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R054	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R055	RESISTOR, 100 OHM 2W 5% CARBON	3050101.	1121.
A3 R056	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R057	RESISTOR, 100 OHM 2W 5% CARBON	3050101.	1121.
A3 R058	RESISTOR, 240 OHM 1/4W 5% CARBON	3070241.	1121.
A3 R059	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
A3 R060	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111.	7115.
A3 R061	RESISTOR,10700 OHM 1/4W 1% METAL FILM	3131072.	7115.
A3 R062	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111.	7115.
A3 R063	RESISTOR, 3900 OHM 1/4W 5% CARBON	3070392.	1121.
A3 R064	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A3 R065	TO		
A3 R067	RESISTOR, 150 OHM 1/2W 5% CARBON	3010151.	1121.
A3 R068	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A3 R069	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122.	1121.
A3 R070	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
A3 R071	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111.	7115.
A3 R072	RESISTOR,10700 OHM 1/4W 1% METAL FILM	3131072.	7115.
A3 R073	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111.	7115.
A3 R074	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A3 R075	RESISTOR, 3900 OHM 1/4W 5% CARBON	3070392.	1121.
A3 R076	TO		
A3 R078	RESISTOR, 150 OHM 1/2W 5% CARBON	3010151.	1121.
A3 R079	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A3 R127	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103.	1121.
A3 U001	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A3 U002	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A3 ZZZZ	HEAT SINK	2000067.	13103.

A4 ATTENUATOR PCB ASSY

A4 A000	ATTENUATOR PCB	4420278.	10597.
A4 C001	CAPACITOR, 22PF MICA	2810530.	853.
A4 L001	COIL ISOLATION	1140050.	10597.
A4 R001	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261.	7115.
A4 R002	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261.	7115.
A4 R003	RESISTOR, 34.8 OHM 1/4W 1% METAL FILM	3130348.	7115.
A4 R004	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A4 R005	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3100412.	7115.
A4 R006	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3100412.	7115.
A4 R007	RESISTOR, 10.0 OHM 1/4W 1% METAL FILM	3130100.	7115.
A4 R008	RESISTOR, 787 OHM 1/4W 1% METAL FILM	3137870.	7115.
A4 R012	RESISTOR, 110 OHM 1/4W 1% METAL FILM	3131100.	7115.
A4 R013	POTENTIOMETER, ATTENUATOR	3110353.	71450.
A4 R014	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499.	7115.
A4 R015	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499.	7115.
A4 S001	TO		
A4 S004	SWITCH, SLIDE	2600364.	10597.

A5 RAMP PCB ASSY

PART	DESCRIPTION	EXACT NO	MFG
A5 A000	RAMP PCB	4420279.	10597.
A5 C001	CAPACITOR, 1000 PF DISC	2830000.	91418.
A5 C002	CAPACITOR, 1000 PF DISC	2830000.	91418.
A5 C003	CAPACITOR, 220PF MICA	2810555.	853.
A5 C004	CAPACITOR, 220PF MICA	2810555.	853.
A5 C005	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A5 C006	CAPACITOR, 10PF MICA	2810529.	853.
A5 C007	CAPACITOR, 22PF MICA	2810530.	853.
A5 C008	CAPACITOR, 220PF MICA	2810555.	853.
A5 C009	CAPACITOR, 220PF MICA	2810555.	853.
A5 C010	CAPACITOR, 10PF MICA	2810529.	853.
A5 C011	CAPACITOR, 1000 PF DISC	2830000.	91418.
A5 C012	CAPACITOR, 22PF MICA	2810530.	853.
A5 C013	CAPACITOR, 1000 PF DISC	2830000.	91418.
A5 C014	TO		
A5 C016	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A5 C017	CAPACITOR, 1000 PF DISC	2830000.	91418.
A5 C018	TO		
A5 C020	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A5 C021	CAPACITOR, 100PF MICA	2810537.	853.
A5 C022	CAPACITOR, 5000 PF DISC	2830011.	91418.
A5 C023	TO		
A5 C026	CAPACITOR, 0.05 UF DISC	2830010.	91418.
A5 C027	CAPACITOR, 7PF MICA	2810536.	853.
A5 C028	CAPACITOR, 1000 PF DISC	2830000.	91418.
A5 C029	CAPACITOR, 220PF MICA	2810555.	853.
A5 D001	DIODE, 1N914	1520914.	7910.
A5 D002	DIODE, 1N914	1520914.	7910.
A5 D003	DIODE, 1N748	1520748.	1295.
A5 D004	DIODE, 1N753A	1520753.	1295.
A5 D005	TO		
A5 D013	DIODE, 1N914	1520914.	7910.
A5 D014	DIODE, 1N748	1520748.	1295.
A5 D015	TO		
A5 D022	DIODE, 1N914	1520914.	7910.
A5 D023	DIODE, HOT CARRIER	1522811.	28480.
A5 D024	TO		
A5 D028	DIODE, 1N914	1520914.	7910.
A5 D029	DIODE, 1N748	1520748.	1295.
A5 D030	TO		
A5 D040	DIODE, 1N914	1520914.	7910.
A5 D041	DIODE, FDH333	1520333.	1295.
A5 D042	DIODE, 1N914	1520914.	7910.
A5 D043	DIODE, 1N914	1520914.	7910.
A5 D044	DIODE, FDH333	1520333.	1295.
A5 D045	DIODE, 1N914	1520914.	7910.
A5 D046	DIODE, FDH333	1520333.	1295.
A5 D047	DIODE, FDH333	1520333.	1295.
A5 D048	DIODE, 1N914	1520914.	7910.
A5 D049	DIODE, 1N914	1520914.	7910.
A5 D050	DIODE, FDH333	1520333.	1295.
A5 D051	DIODE, 1N914	1520914.	7910.
A5 D052	DIODE, FDH333	1520333.	1295.
A5 D053	DIODE, 1N914	1520914.	7910.
A5 D054	DIODE, FDH333	1520333.	1295.
A5 D055	DIODE, 1N914	1520914.	7910.
A5 D056	DIODE, FDH333	1520333.	1295.
A5 D057	DIODE, FDH333	1520333.	1295.
A5 D058	DIODE, 1N914	1520914.	7910.
A5 D059	DIODE, FDH333	1520333.	1295.
A5 D060	DIODE, 1N914	1520914.	7910.
A5 L001	CHOKE 6 TURN BEAD	1140032.	10597.
A5 L002	CHOKE 6 TURN BEAD	1140032.	10597.
A5 L003	BEAD, FERRITE G303	1140034.	1121.
A5 L004	TO		
A5 L006	CHOKE 6 TURN BEAD	1140032.	10597.
A5 L007	BEAD, FERRITE G303	1140034.	1121.
A5 L008	CHOKE 6 TURN BEAD	1140032.	10597.
A5 L009	CHOKE 6 TURN BEAD	1140032.	10597.
A5 L010	TO		
A5 L015	BEAD, FERRITE G303	1140034.	1121.
A5 Q001	TO		
A5 Q004	TRANSISTOR, 2N4258	1564258.	7263.
A5 Q005	TRANSISTOR, TIS87	1560087.	1295.
A5 Q006	TRANSISTOR, TIS87	1560087.	1295.
A5 Q007	TRANSISTOR, MPS3563	1563563.	4713.
A5 Q008	TRANSISTOR, MPS3646	1563646.	4713.
A5 Q009	TRANSISTOR, 2N4121	1564121.	7263.
A5 Q010	TRANSISTOR, 2N4121	1564121.	7263.
A5 Q011	TRANSISTOR, MPS3646	1563646.	4713.
A5 Q012	TRANSISTOR, 2N4121	1564121.	7263.
A5 Q013	TRANSISTOR, 2N4121	1564121.	7263.
A5 Q014	TRANSISTOR, 2N2219	1562219.	1295.
A5 Q015	TRANSISTOR, 2N2905	1562905.	1295.
A5 Q016	TRANSISTOR, EN2484	1562484.	7263.
A5 Q017	TRANSISTOR, 2N5462	1565462.	4713.
A5 Q018	TRANSISTOR, 2N4250	1564250.	7263.
A5 Q019	TRANSISTOR, EN2484	1562484.	7263.
A5 Q020	TRANSISTOR, 2N4250	1564250.	7263.
A5 Q021	TRANSISTOR, 2N5245	1565245.	1295.
A5 Q022	TRANSISTORS, MATCHED 2N5485	1575485.	10597.
A5 Q023	TRANSISTOR, MPS3646	1563646.	4713.
A5 Q024	TRANSISTOR, MPS3646	1563646.	4713.
A5 R001	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103.	1121.
A5 R002	RESISTOR, 1600 OHM 1/4W 5% CARBON	3070162.	1121.
A5 R003	RESISTOR, 75K OHM 1/4W 5% CARBON	3070753.	1121.
A5 R004	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A5 R005	RESISTOR, 120K OHM 1/4W 5% CARBON	3070124.	1121.
A5 R006	TO		
A5 R008	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471.	1121.
A5 R009	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
A5 R010	RESISTOR, 7500 OHM 1/4W 5% CARBON	3070752.	1121.
A5 R011	RESISTOR, 1100 OHM 1/4W 5% CARBON	3070112.	1121.
A5 R012	RESISTOR, 7500 OHM 1/4W 5% CARBON	3070752.	1121.
A5 R013	RESISTOR, 6800 OHM 1/4W 5% CARBON	3070682.	1121.
A5 R014	RESISTOR, 56K OHM 1/4W 5% CARBON	3070563.	1121.
A5 R015	TO		
A5 R019	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471.	1121.
A5 R020	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242.	1121.
A5 R021	RESISTOR, 3900 OHM 1/4W 5% CARBON	3070392.	1121.
A5 R022	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222.	1121.
A5 R023	RESISTOR, 4300 OHM 1/4W 5% CARBON	3070432.	1121.
A5 R024	RESISTOR, 220 OHM 1/2W 5% CARBON	3010221.	1121.
A5 R025	RESISTOR, 750 OHM 1/4W 5% CARBON	3070751.	1121.
A5 R026	RESISTOR, 3900 OHM 1/4W 5% CARBON	3070392.	1121.
A5 R027	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332.	1121.
A5 R028	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A5 R029	RESISTOR, 1820 OHM 1/4W 1% METAL FILM	3131821.	7115.
A5 R030	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211.	7115.
A5 R031	POTENTIOMETER, 50K OHM TRIM	3110350.	71450.
A5 R032	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000.	7115.
A5 R033	RESISTOR, 3920 OHM 1/4W 1% METAL FILM	3133921.	7115.
A5 R034	RESISTOR, 3920 OHM 1/4W 1% METAL FILM	3133921.	7115.
A5 R035	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001.	7115.
A5 R036	RESISTOR, 9090 OHM 1/4W 1% METAL FILM	3139091.	7115.
A5 R037	RESISTOR, 5490 OHM 1/4W 1% METAL FILM	3135491.	7115.
A5 R038	RESISTOR, 402 OHM 1/4W 1% METAL FILM	3134020.	7115.
A5 R039	RESISTOR, 402 OHM 1/4W 1% METAL FILM	3134020.	7115.
A5 R040	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A5 R041	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A5 R042	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A5 R043	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A5 R044	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302.	1121.
A5 R045	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001.	7115.
A5 R046	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A5 R047	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A5 R048	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A5 R049	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302.	1121.
A5 R050	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A5 R051	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
A5 R052	RESISTOR, 80.6K OHM 1/4W 1% METAL FILM	3138062.	7115.
A5 R053	RESISTOR, 40.2K OHM 1/4W 1% METAL FILM	3134022.	7115.
A5 R054	RESISTOR,20000 OHM 1/4W 1% METAL FILM	3132002.	7115.
A5 R055	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
A5 R056	RESISTOR,13700 OHM 1/4W 1% METAL FILM	3131372.	7115.
A5 R057	POTENTIOMETER, 1K OHM TRIM	3110347.	71450.
A5 R058	RESISTOR,26100 OHM 1/4W 1% METAL FILM	3132612.	7115.
A5 R059	RESISTOR, 1500 OHM 1/4W 1% METAL FILM	3131501.	7115.
A5 R060	RESISTOR, 1540 OHM 1/4W 1% METAL FILM	3131541.	7115.
A5 R061	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A5 R062	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211.	7115.
A5 R063	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A5 R064	RESISTOR, 2490 OHM 1/4W 1% METAL FILM	3132491.	7115.
A5 R065	RESISTOR, 750 OHM 1/4W 5% CARBON	3070751.	1121.
A5 R066	RESISTOR, 270 OHM 1/2W 5% CARBON	3010271.	1121.
A5 R067	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121.	1121.
A5 R068	POTENTIOMETER, 2K OHM TRIM	3110348.	71450.
A5 R069	RESISTOR, 8250 OHM 1/4W 1% METAL FILM	3138251.	7115.
A5 R070	RESISTOR, 1000K OHM 1/4W 1% METAL FILM	3131004.	7115.
A5 R071	RESISTOR,31600 OHM 1/4W 1% METAL FILM	3133162.	7115.
A5 R072	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333.	1121.
A5 R073	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333.	1121.
A5 R074	RESISTOR, 620 OHM 1/4W 5% CARBON	3070621.	1121.
A5 R075	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001.	7115.
A5 R076	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A5 R077	RESISTOR, 523 OHM 1/4W 1% METAL FILM	3135230.	7115.
A5 R078	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220.	1121.
A5 R079	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A5 R080	RESISTOR,24900 OHM 1/4W 1% METAL FILM	3132492.	7115.
A5 R081	POTENTIOMETER, 1K OHM TRIM	3110347.	71450.
A5 R082	RESISTOR, 4530 OHM 1/4W 1% METAL FILM	3134531.	7115.
A5 R083	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333.	1121.
A5 R084	RESISTOR, 1.0 OHM 1/2W 5% CARBON	3010010.	1121.
A5 R085	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470.	1121.
A5 R086	RESISTOR, 953 OHM 1/4W 1% METAL FILM	3139530.	7115.
A5 R087	POTENTIOMETER, 50K OHM TRIM	3110350.	71450.
A5 R088	RESISTOR, 49.9K OHM 1/4W 1% METAL FILM	3134992.	7115.
A5 R089	RESISTOR, 806 OHM 1/4W 1% METAL FILM	3138060.	7115.
A5 R090	RESISTOR, 620 OHM 1/4W 5% CARBON	3070621.	1121.
A5 R091	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333.	1121.
A5 R092	RESISTOR, 1.0 OHM 1/2W 5% CARBON	3010010.	1121.
A5 R093	RESISTOR, 976 OHM 1/4W 1% METAL FILM	3139760.	7115.
A5 R094	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001.	7115.
A5 R095	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220.	1121.
A5 R096	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A5 R097	RESISTOR, 2740 OHM 1/4W 1% METAL FILM	3132741.	7115.
A5 R098	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A5 R099	RESISTOR, 150 OHM 1/2W 5% CARBON	3010151.	1121.
A5 R100	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A5 R101	RESISTOR, 383 OHM 1/2W 1% METAL FILM	3103830.	7115.
A5 R102	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333.	1121.
A5 U001	INTEGRATED CIRCUIT, UA710C	1580020.	7263.
A5 U002	IC, SN7427	1587427.	1295.
A5 U003	INTEGRATED CIRCUIT, SN7402N	1580021.	1295.
A5 U004	INTEGRATED CIRCUIT,SN7493	1587493.	1295.
A5 U005	INTEGRATED CIRCUIT, SN7410N	1580032.	1295.
A5 U006	INTEGRATED CIRCUIT, SN7442N	1580027.	1295.
A5 U007	INTEGRATED CIRCUIT, SN7400N	1580011.	1295.
A5 U008	TO		
A5 U011	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A5 U012	OP AMP, CA3140S	1583140.	2735.
A5 U013	TO		
A5 U015	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A5 U016	OP AMP, CA3140S	1583140.	2735.

A6 FRONT PANEL ASSY

PART	DESCRIPTION	EXACT NO	MFG
A6 J001	CONNECTOR, BNC	1310047.	91836.
A6 J002	CONNECTOR, BNC	1310047.	91836.
A6 R001	POTENTIOMETER, 20K	3110341.	10597.
A6 R002	POTENTIOMETER, 1K	3110342.	10597.
A6 R003	POTENTIOMETER, 10K OHM MIN	3110327.	71450.
A6 S001	SWITCH, POWER	2600407.	10597.
A6 S002	SWITCH, MODE	2600408.	10597.
A6 S003	SWITCH, RAMP MODE	2600409.	10597.
A6 S004	FREQUENCY SWITCH ASSY	2611399.	10597.
A6 S005	SWITCH, RANGE	2600400.	10597.
A6 S006	FREQUENCY SWITCH ASSY	2611399.	10597.
A6 S007	SWITCH, FUNCTION	2600418.	10597.
A6 S008	SWITCH, ROTARY	2600345.	10597.
A6 S009	SWITCH, KVD	2600704.	10597.
A6 S401	TO		
A6 S412	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
A6 S413	POTENTIOMETER, 100 OHM TRIM	3110345.	71450.
A6 S601	TO		
A6 S612	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
A6 S8C1	CAPACITOR, TIMING SET	2950004.	10597.
A6 S8C2	CAPACITOR, 68PF MICA	2810523.	853.
A6 S8C3	CAPACITOR, 5PF MICA	2810501.	853.
A6 S901	TO		
A6 S912	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.

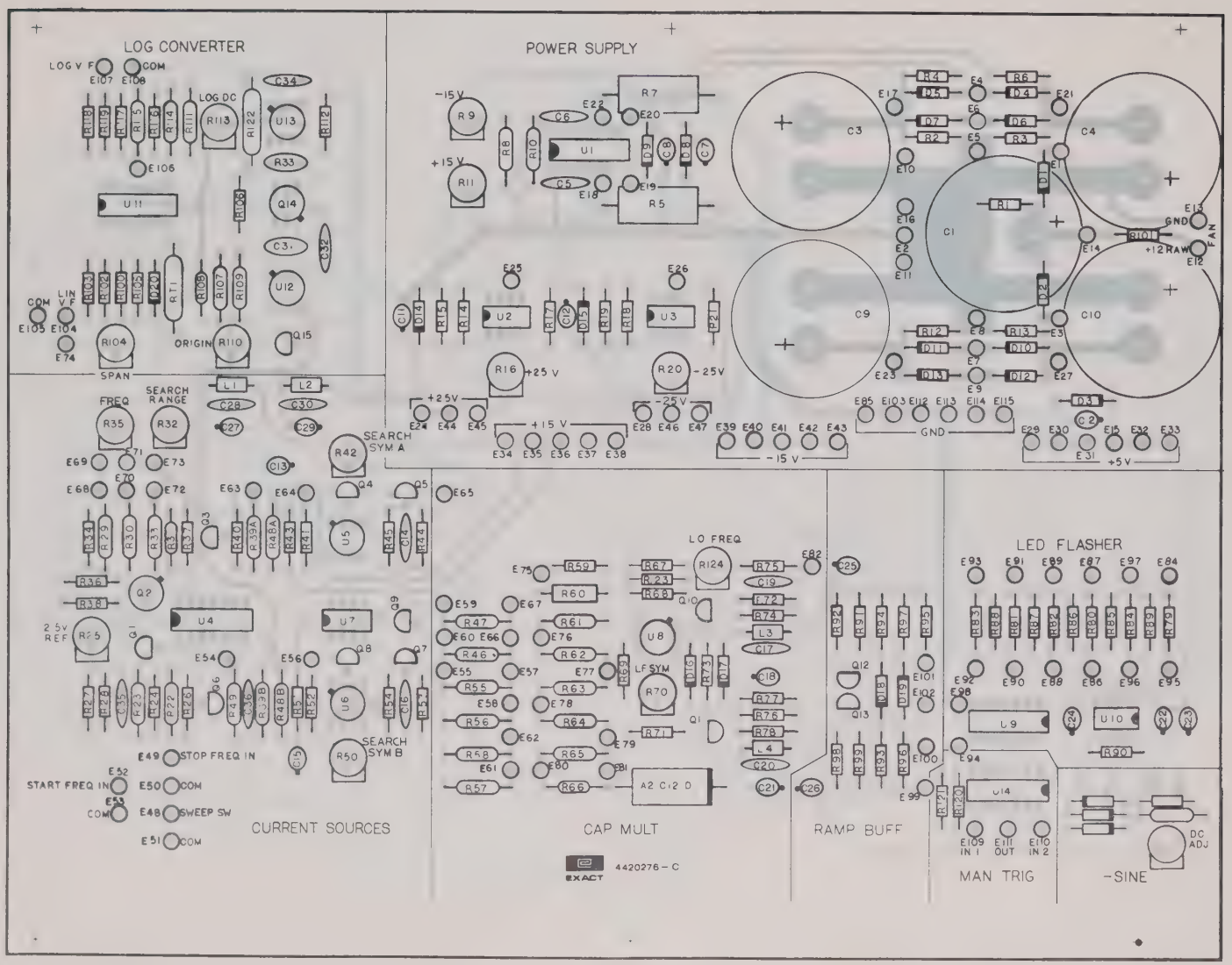
PART	DESCRIPTION	EXACT NO	MFG
A7 REAR PANEL			
A7 C001	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A7 F001	FUSE, 1-1/2 SLO BLO	1590031.	71400.
A7 J001	BINDING POST, WHITE	3550535.	10597.
A7 J002	BINDING POST, BLACK	3550536.	10597.
A7 J003	CONNECTOR, BNC	1310047.	91836.
A7 J004	CONNECTOR, BNC	1310047.	91836.
A7 J005	TO		
A7 J008	CONNECTOR, BNC	1310047.	91836.
A7 L001	CHOKE 6 TURN BEAD	1140032.	10597.
A7 L002	CHOKE 6 TURN BEAD	1140032.	10597.
A7 Q001	TRANSISTOR, 2N4918	1564918.	4713.
A7 Q002	TRANSISTOR, 2N4921	1564921.	4713.
A7 Q003	TRANSISTOR, 2N4918	1564918.	4713.
A7 Q004	TRANSISTOR, 2N4921	1564921.	4713.
A7 S001	SWITCH, SLIDE	2600319.	10597.
A7 T001	TRANSFORMER, POWER	1200045.	10597.
A7 U001	REGULATOR THREE TERM.	1587805.	4713.
A7 U002	REGULATOR +24V MC7824	1587824.	4713.
A7 U003	REGULATOR, -24V MC7924	1587924.	4713.
A7 XF01	FUSE POST	1360103.	75915.
A7 ZZZZ	GROMMET, 3/8	1740003.	10597.
A7 ZZZZ	POWER CORD, 3 WIRE	1750203.	10597.
A7 ZZZZ	FAN MOTOR	2010101.	5624.
A8 START FREQUENCY LED ASSY			
A8 A000	PCB, LED	4430002.	10597.
A8 D001	TO		
A8 D003	LED	1520005.	72619.
A9 STOP FREQUENCY LED ASSY			
A9 A000	PCB, LED	4430002.	10597.
A9 D001	TO		
A9 D003	LED	1520005.	72619.
A10 RAMP DISPLAY PCB ASSY			
A10 A000	PCB, LED	4430001.	10597.
A10 D001	TO		
A10 D011	LED, MLED650	1520002.	4713.

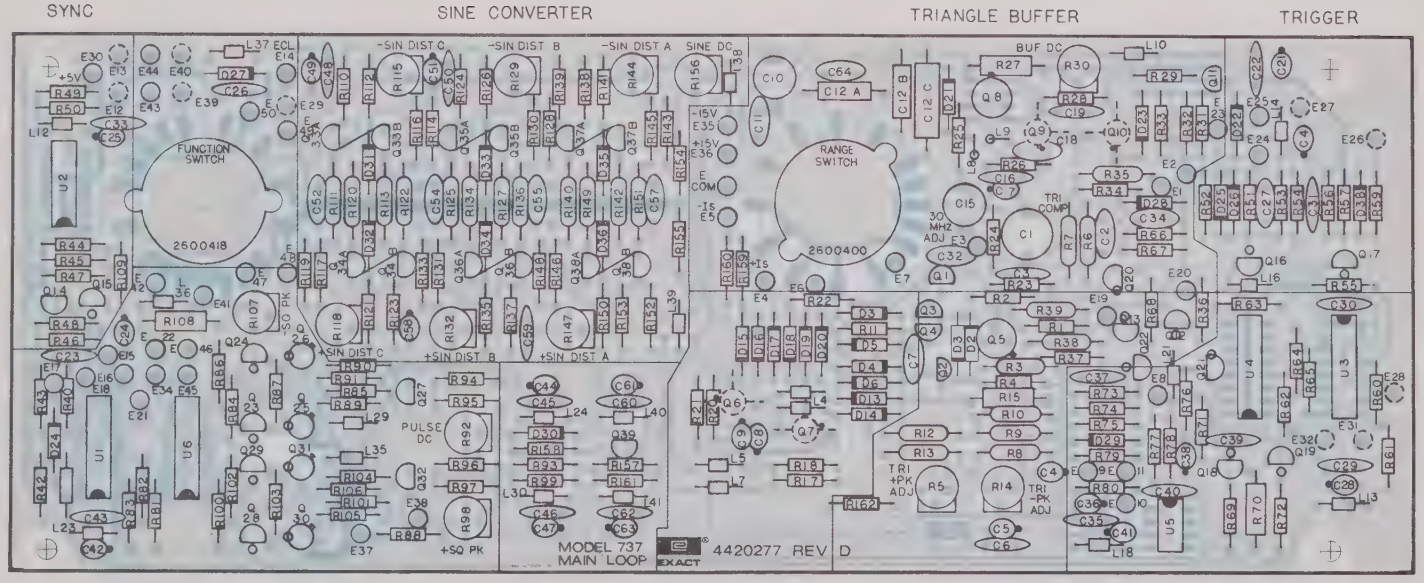
SECTION 7

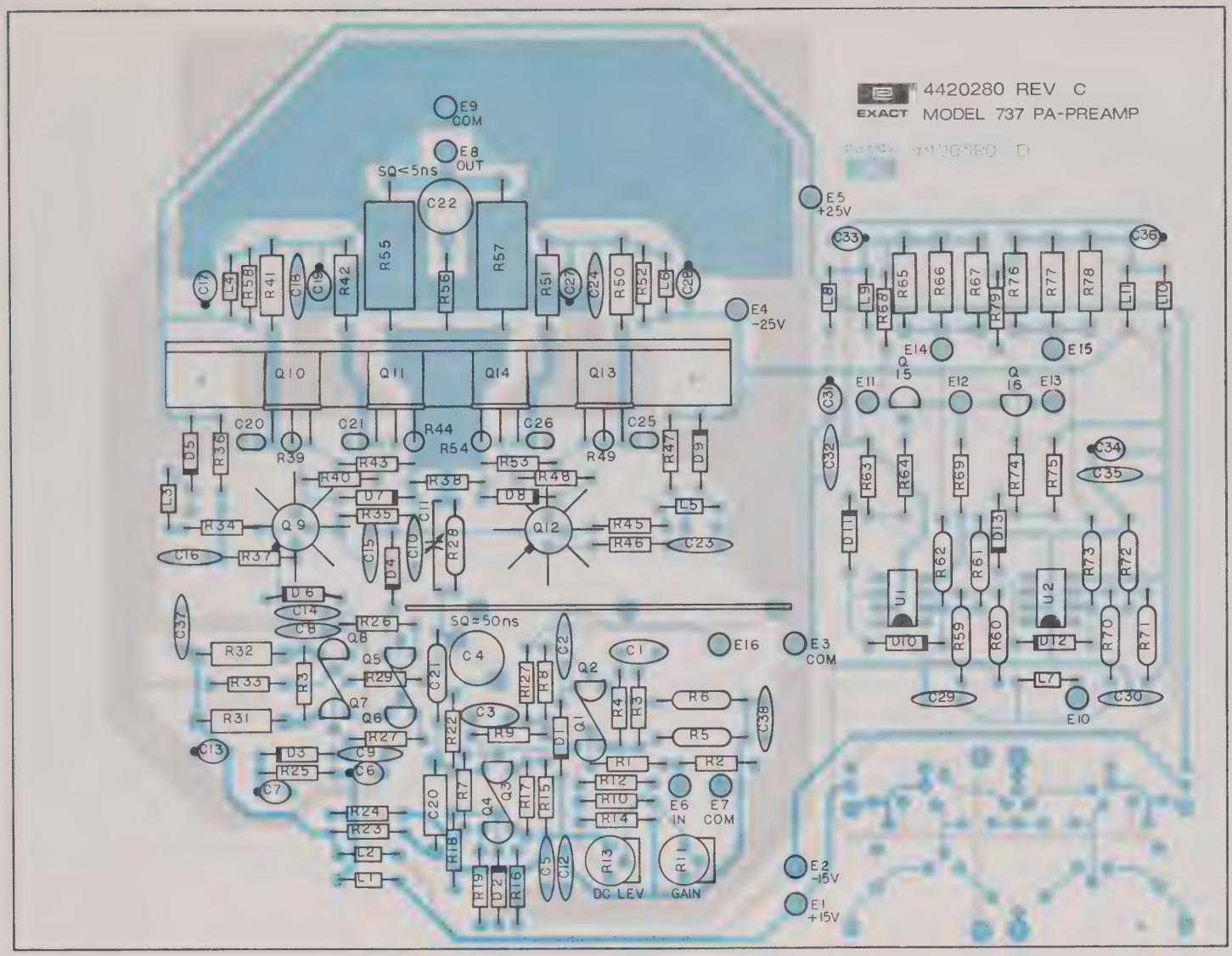
PARTS OVERLAY AND SCHEMATICS

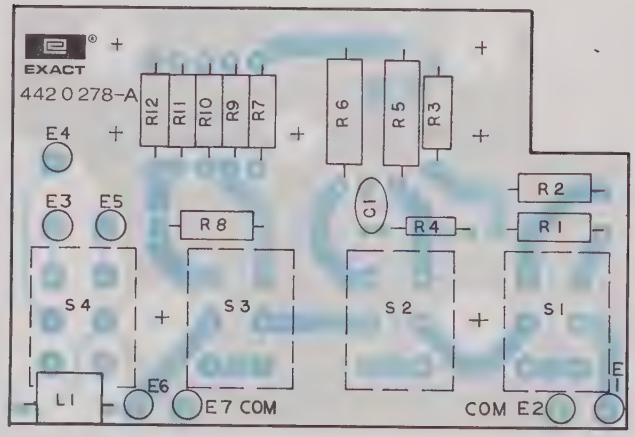
FOREWORD TO SCHEMATICS

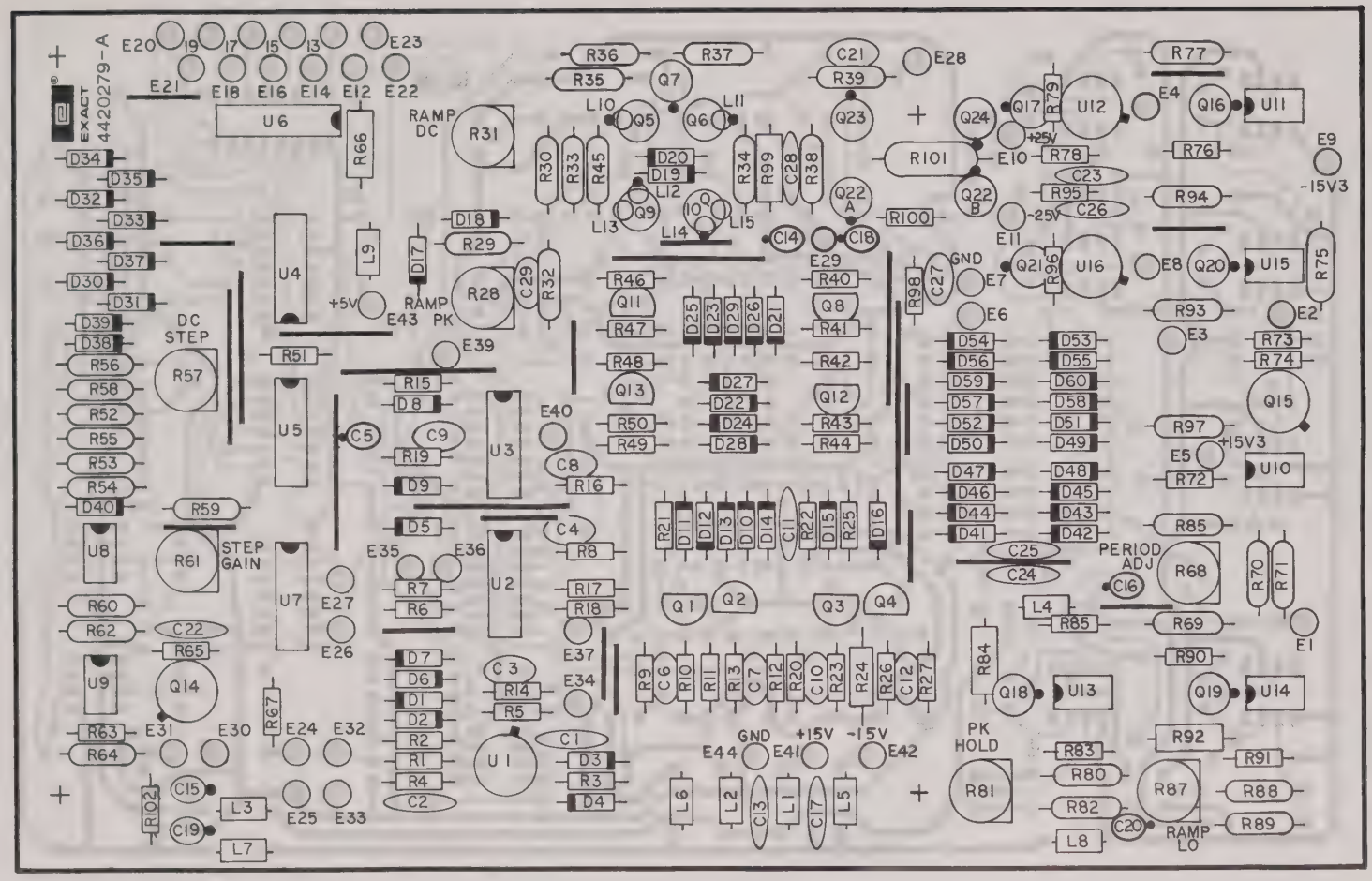
To facilitate quick reference to inter-connections from one schematic to another, a system of numbers has been utilized. Each schematic carries its own identifying number located in a large hexagonal shape near the title. When a connection is referred to, a small hex encompasses the number of the schematic that contains the connection.

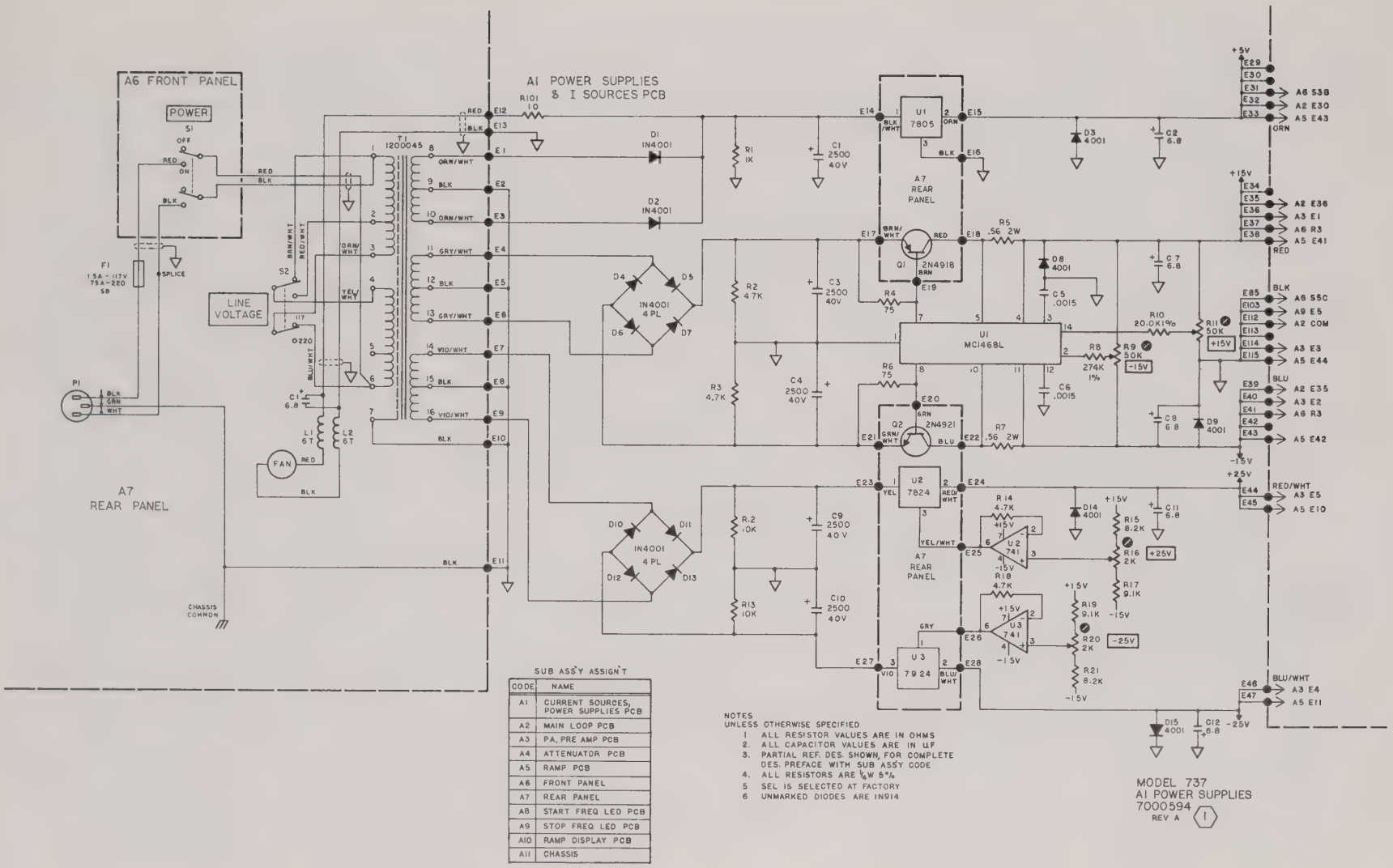

LOG CONVERTER
POWER SUPPLY
CURRENT SOURCES
CAP MULT
RAMP BUFF
LED FLASHER
MAN TRIG
-SINE
SPAN
ORIGIN
FREQ
SEARCH RANGE
SEARCH SYM A
SEARCH SYM B
LO FREQ
LF SYM
2.5V REF
START FREQ IN
STOP FREQ IN
SWEEP SW
+25 V
-25V
+15 V
-15 V
GND
+5V
+12 RAW
FAN
DC ADJ
EXACT
4420276-C


SYNC
SINE CONVERTER
TRIANGLE BUFFER
TRIGGER
FUNCTION SWITCH
2600418
RANGE SWITCH
2600400
MODEL 737
MAIN LOOP
EXACT
4420277 REV D
SQUARE SWITCH
POWER SUPPLY
BRIDGE
LEVEL DET.
LOCKOUT LOGIC


4420280 REV C
EXACT MODEL 737 PA-PREAMP
E9 COM
E8 OUT
SQ<5ns
C22
R55
R57
R56
E5 +25V
E4 -25V
Q10
Q11
Q14
Q13
R39
R54
R44
R49
Q9
Q12
SQ=50ns
E16
E3 COM
E6 IN
E7 COM
DC LEV
GAIN
E2 -15V
E1 +15V
E14
E15
E11
E12
E13
U1
U2
E10


EXACT
442 0 278-A
R12
R11
R10
R9
R7
R6
R5
R3
R2
R1
R8
R4
C1
E4
E3
E5
S4
S3
S2
S1
L1
E6
E7 COM
COM E2
E


EXACT
4420279-A
E20
19
17
15
13
E23
E21
E18
E16
E14
E12
E22
U6
R66
RAMP DC
R31
R36
R37
R35
Q7
C21
R39
E28
R77
L10
Q5
Q6
L11
Q23
Q24
Q17
R79
U12
E4
Q16
U11
R101
E10
+25V
R78
R76
E9
-15V3
C23
R95
C26
-25V
R94
R30
R33
R45
D20
D19
L12
L13
Q9
L14
L15
R34
R99
C28
R38
Q22 A
Q22 B
R100
E11
D34
D35
D32
D33
D36
D37
D30
D31
D39
D38
R56
R58
R52
R55
R53
R54
D40
U4
L9
D17
D18
R29
+5V
E43
RAMP PK
R28
C29
R32
C14
C18
E29
R46
Q11
R47
R48
Q13
R50
R49
D25
D23
D29
D26
D21
D27
D22
D24
D28
Q8
R40
R41
R42
Q12
R43
R44
R98
C27
GND
E7
Q21
R96
U16
E8
Q20
U15
R75
R93
E2
E6
E3
R73
R74
Q15
D54
D56
D59
D57
D52
D50
D53
D55
D60
D58
D51
D49
R97
+15V3
E5
R72
U10
D47
D46
D44
D41
D48
D45
D43
D42
C25
C24
PERIOD ADJ
C16
R68
R85
R70
R71
E1
L4
R85
R69
R90
R84
Q18
U13
Q19
U14
R92
R91
R88
R89
R83
R80
R82
L8
R87
C20
RAMP LO
PK HOLD
R81
R51
E39
R15
D8
U5
C5
C9
R19
D9
U3
E40
C8
R16
C4
R8
R17
R18
E37
E34
R21
D11
D12
D13
D10
D14
C11
R22
D15
R25
D16
Q1
Q2
Q3
Q4
R9
C6
R10
R11
R13
C7
R12
R20
C10
R23
R24
R26
C12
R27
GND
+15V
-15V
E44
E41
E42
L6
L2
C13
L1
C17
L5
R57
DC STEP
R59
R61
STEP GAIN
U8
U7
E35
E36
E27
E26
R7
R6
U2
D5
D7
D6
D1
D2
R2
R1
R4
C2
C3
R14
R5
U1
C1
D3
R3
D4
R60
R62
C22
R65
U9
Q14
R63
R64
E31
E30
R67
E24
E32
E25
E33
R102
C15
C19
L3
L7

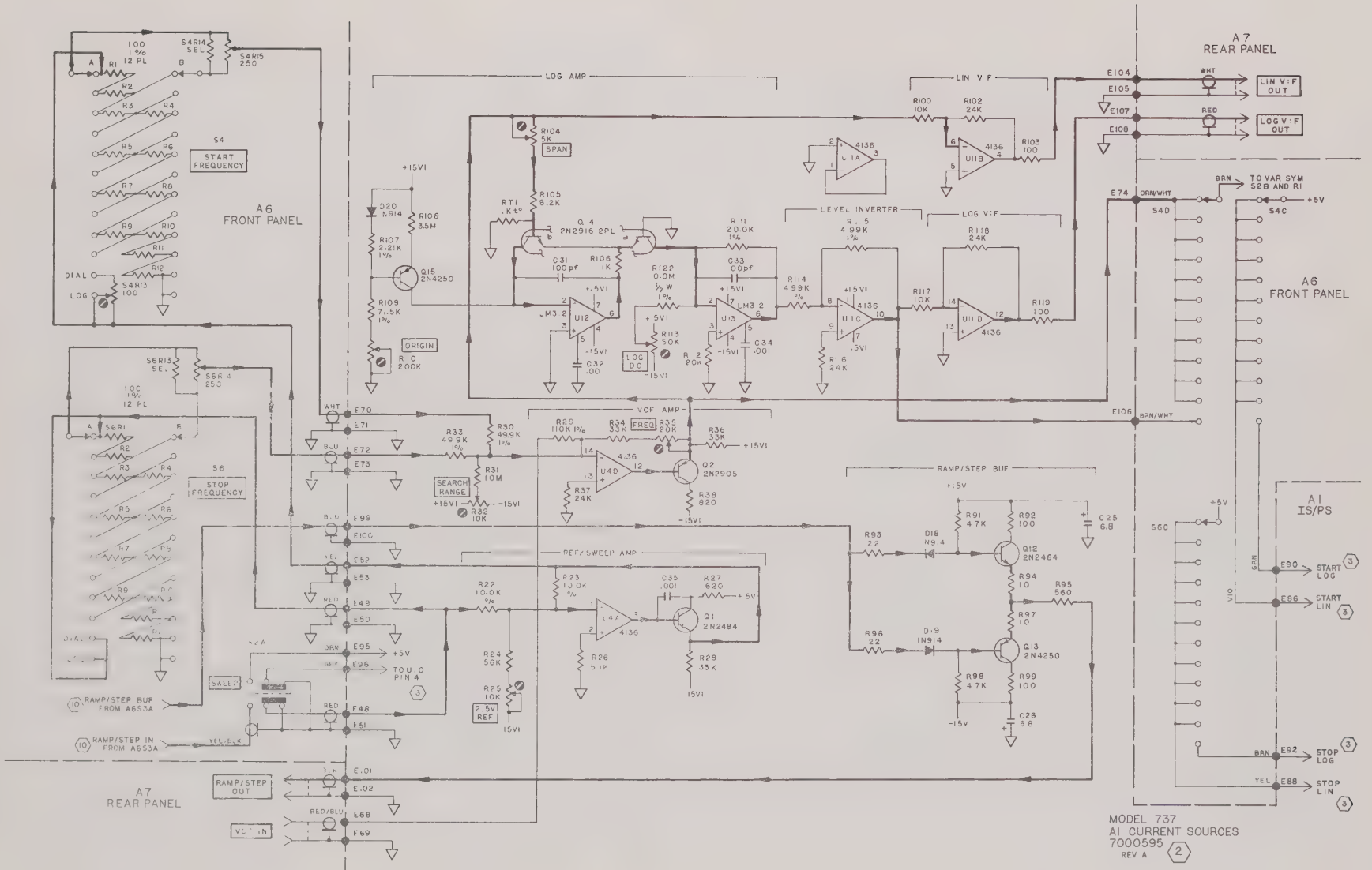


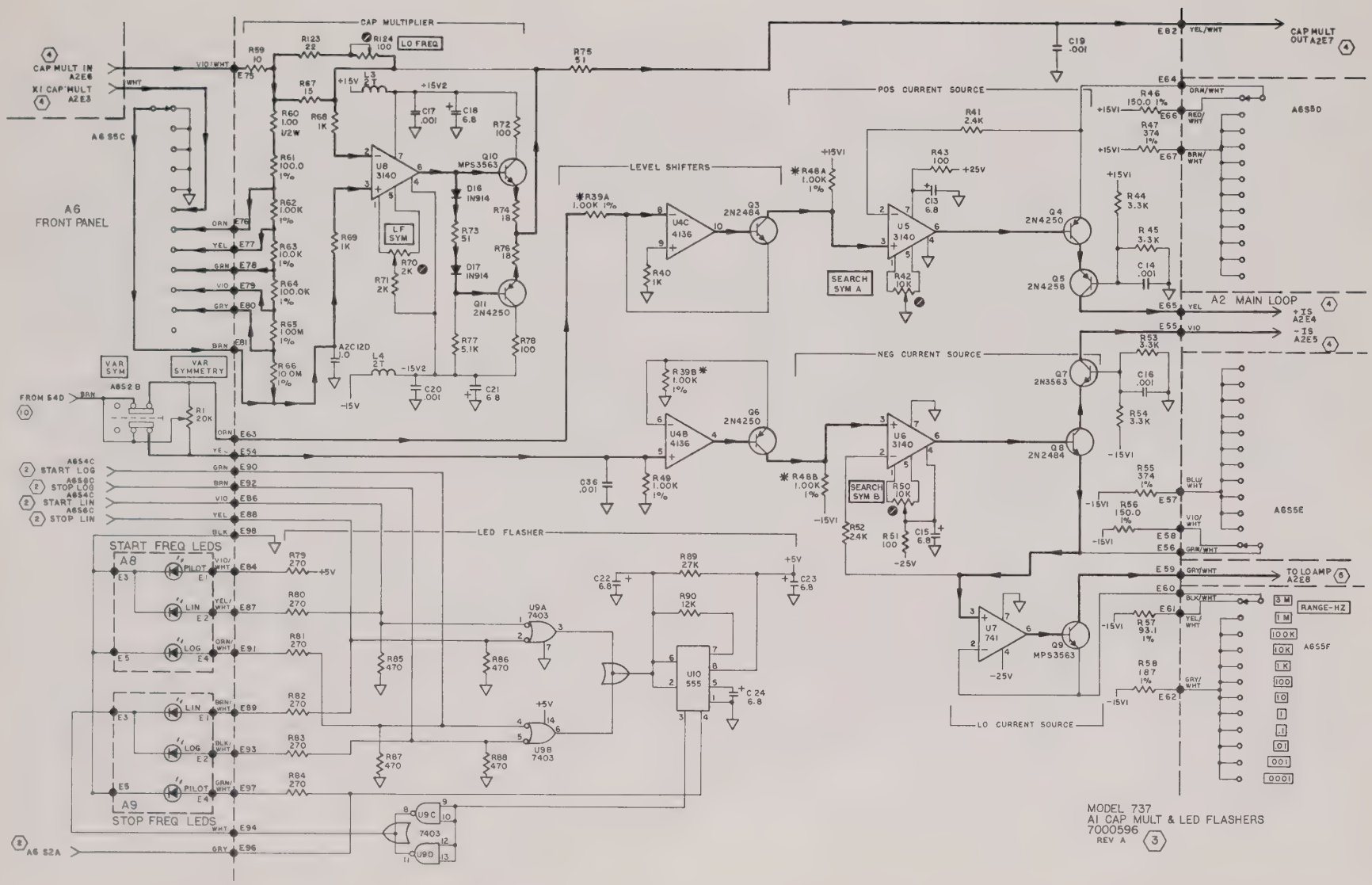
SUB ASS'Y ASSIGN'T

CODE	NAME
A1	CURRENT SOURCES, POWER SUPPLIES PCB
A2	MAIN LOOP PCB
A3	PA, PRE AMP PCB
A4	ATTENUATOR PCB
A5	RAMP PCB
A6	FRONT PANEL
A7	REAR PANEL
A8	START FREQ LED PCB
A9	STOP FREQ LED PCB
A10	RAMP DISPLAY PCB
A11	CHASSIS

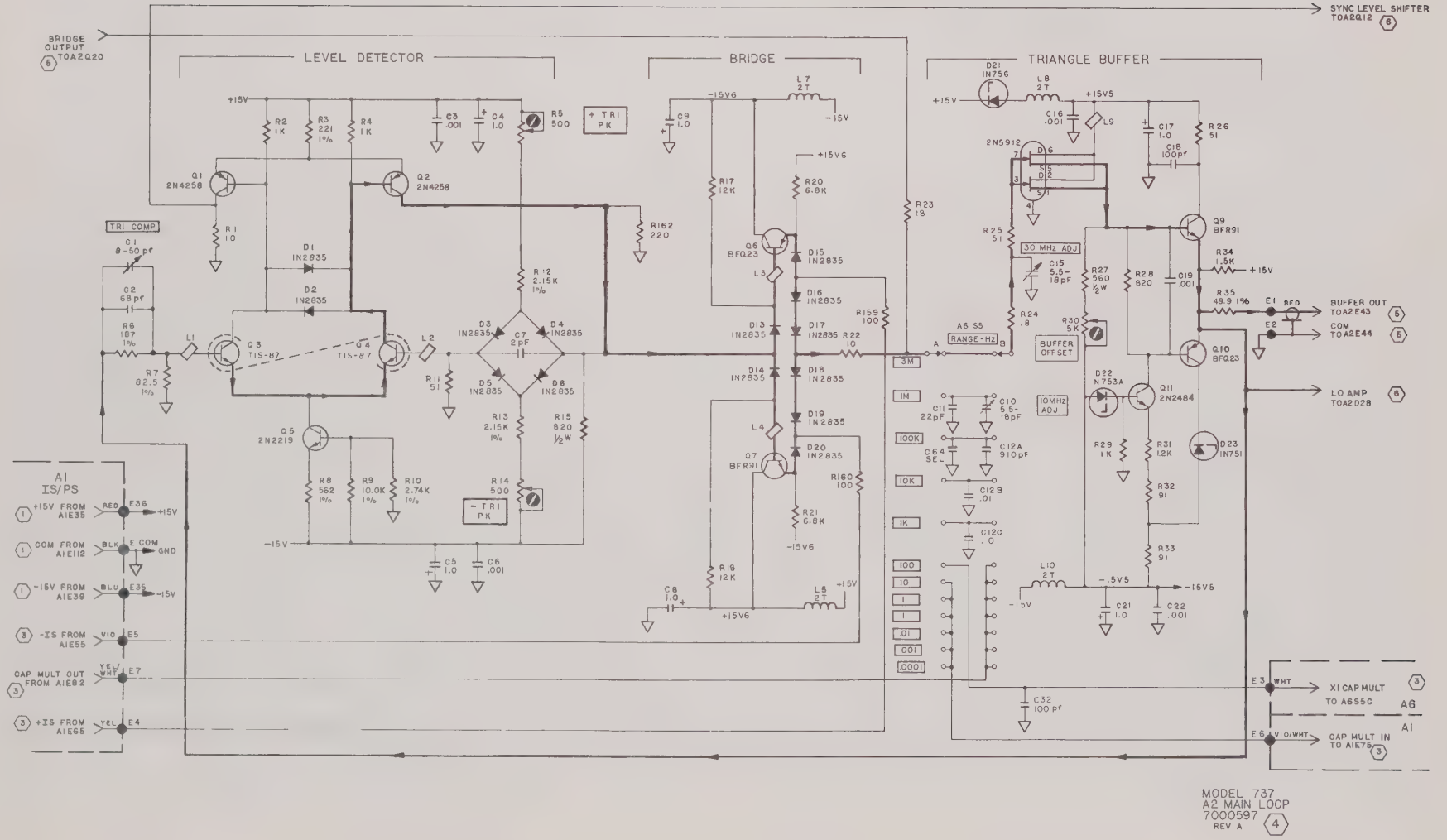
NOTES
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTOR VALUES ARE IN OHMS
2. ALL CAPACITOR VALUES ARE IN UF
3. PARTIAL REF. DES. SHOWN, FOR COMPLETE DES. PREFACE WITH SUB ASS'Y CODE
4. ALL RESISTORS ARE ¼W 5%
5. SEL IS SELECTED AT FACTORY
6. UNMARKED DIODES ARE IN914

MODEL 737
A1 POWER SUPPLIES
7000594
REV A (1)

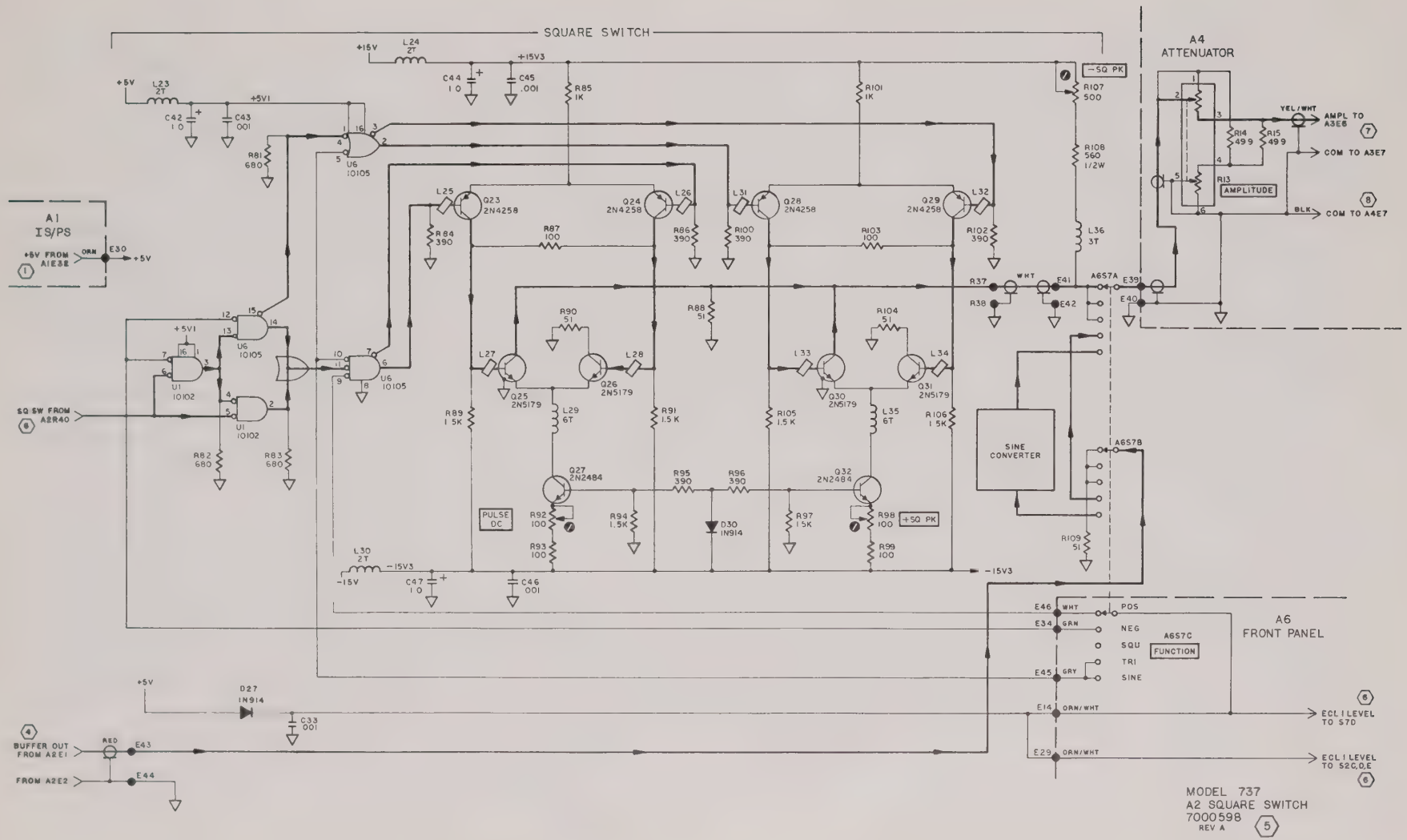

A7
REAR PANEL
A6
FRONT PANEL
LOG AMP
LIN V:F
LEVEL INVERTER
LOG V:F
VCF AMP
REF/SWEEP AMP
RAMP/STEP BUF
S4
START FREQUENCY
S6
STOP FREQUENCY
SEARCH RANGE
SPAN
ORIGIN
LOG DC
2.5V REF
LIN V:F OUT
LOG V:F OUT
TO VAR SYM S2B AND R1
A1
IS/PS
START LOG
START LIN
STOP LOG
STOP LIN
RAMP/STEP OUT
RAMP/STEP BUF FROM A6S3A
RAMP/STEP IN FROM A6S3A
MODEL 737
A1 CURRENT SOURCES
7000595
REV A

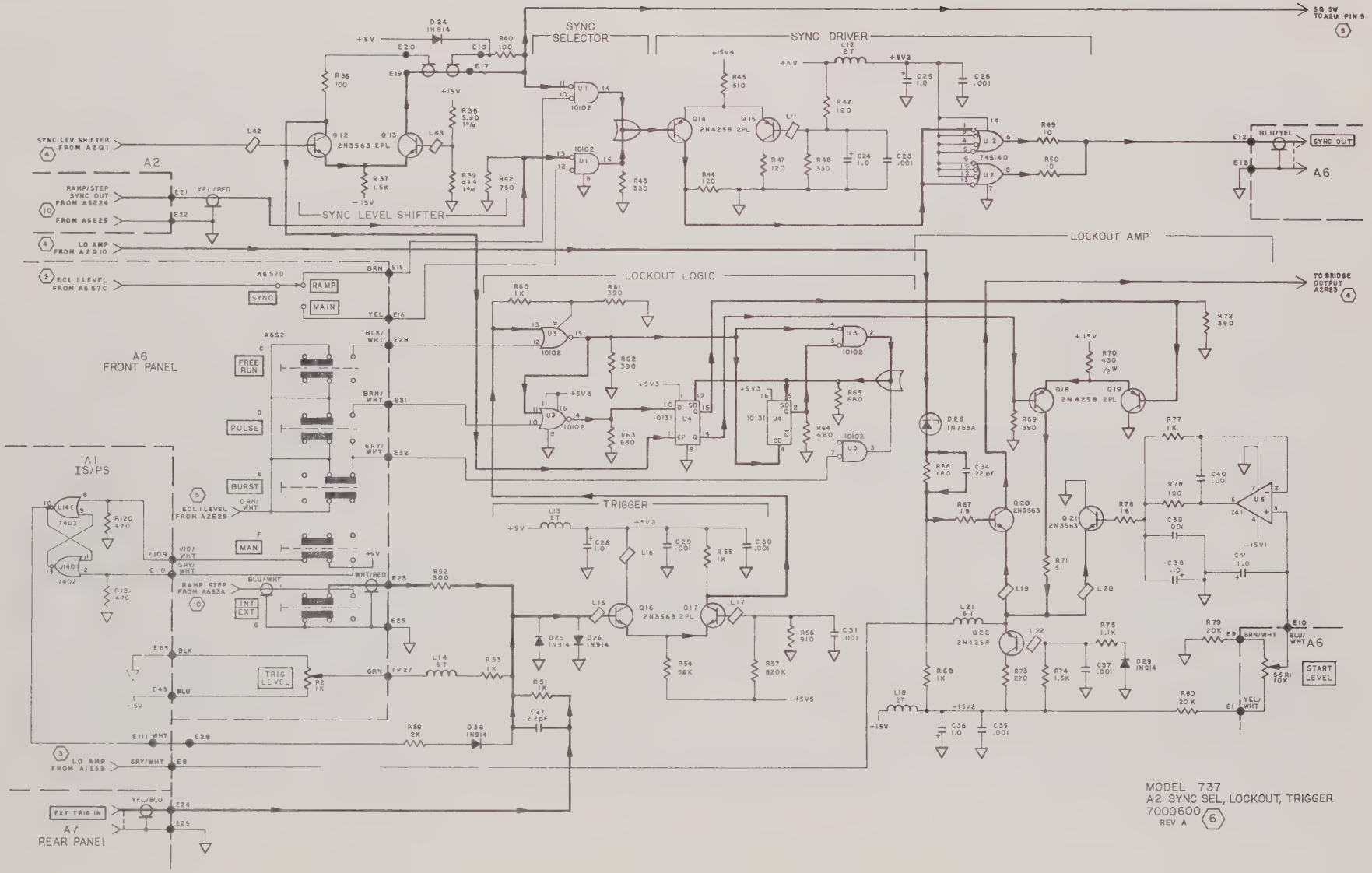


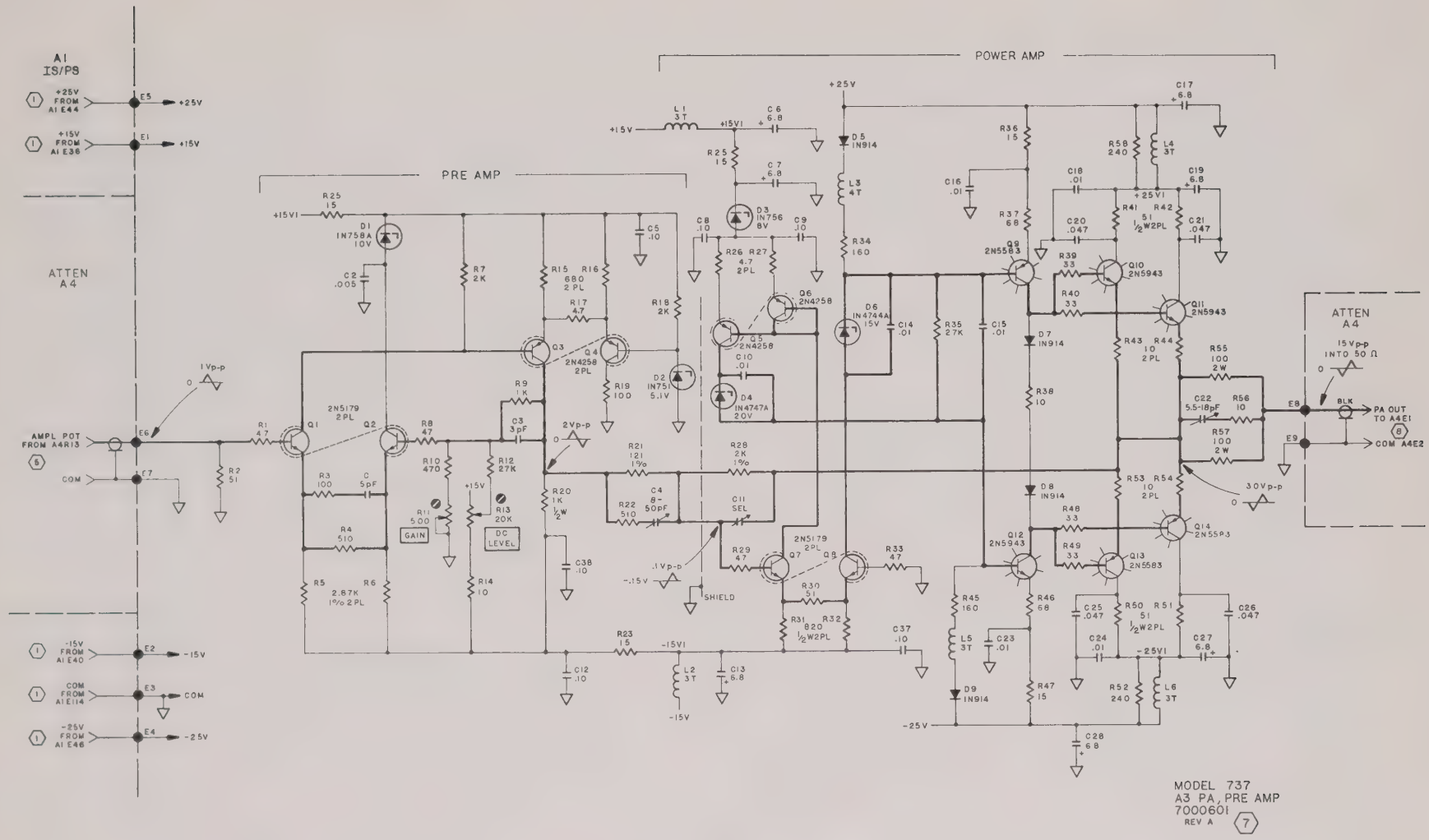
MODEL 737
A1 CAP MULT & LED FLASHERS
7000596
REV A
3

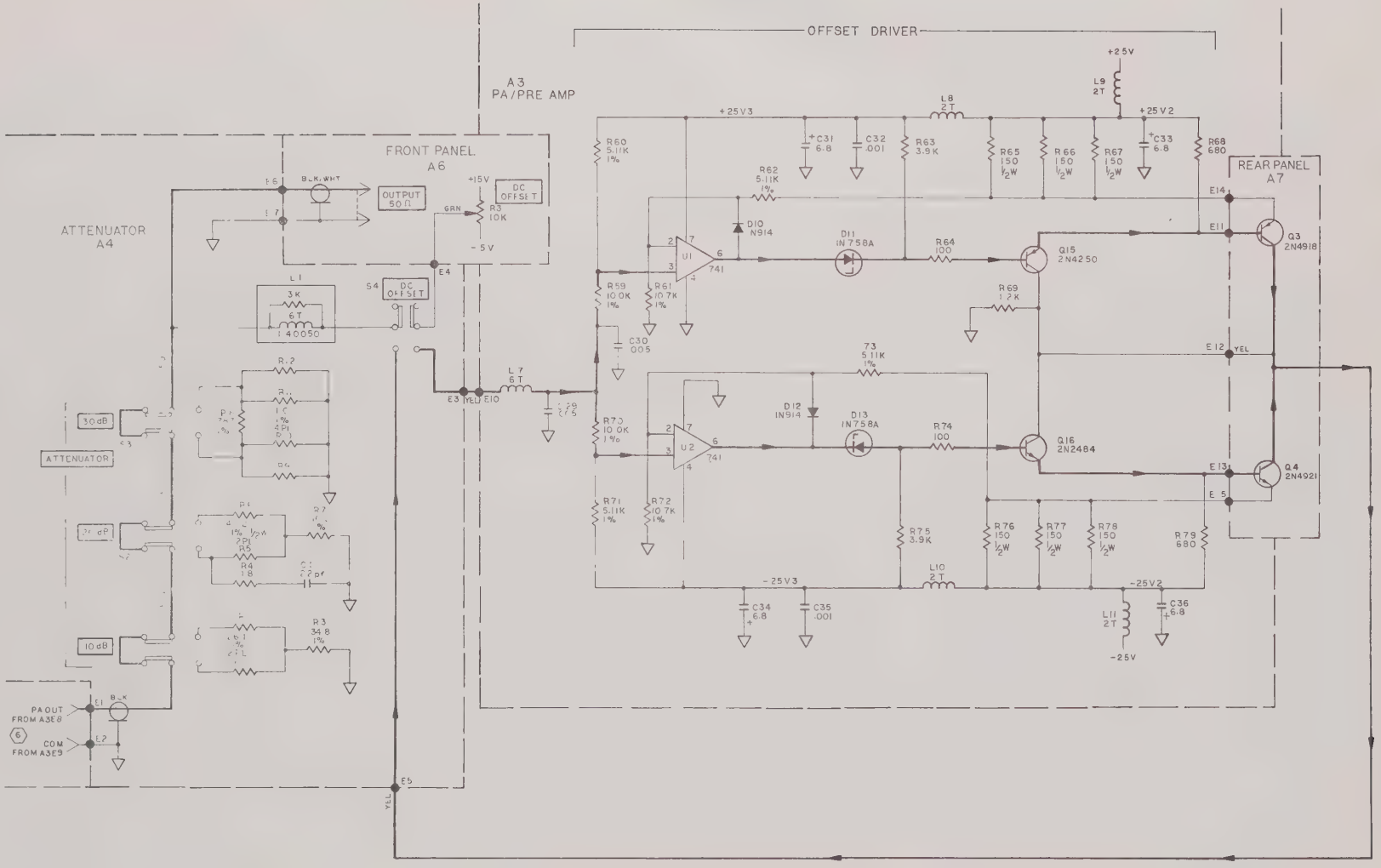


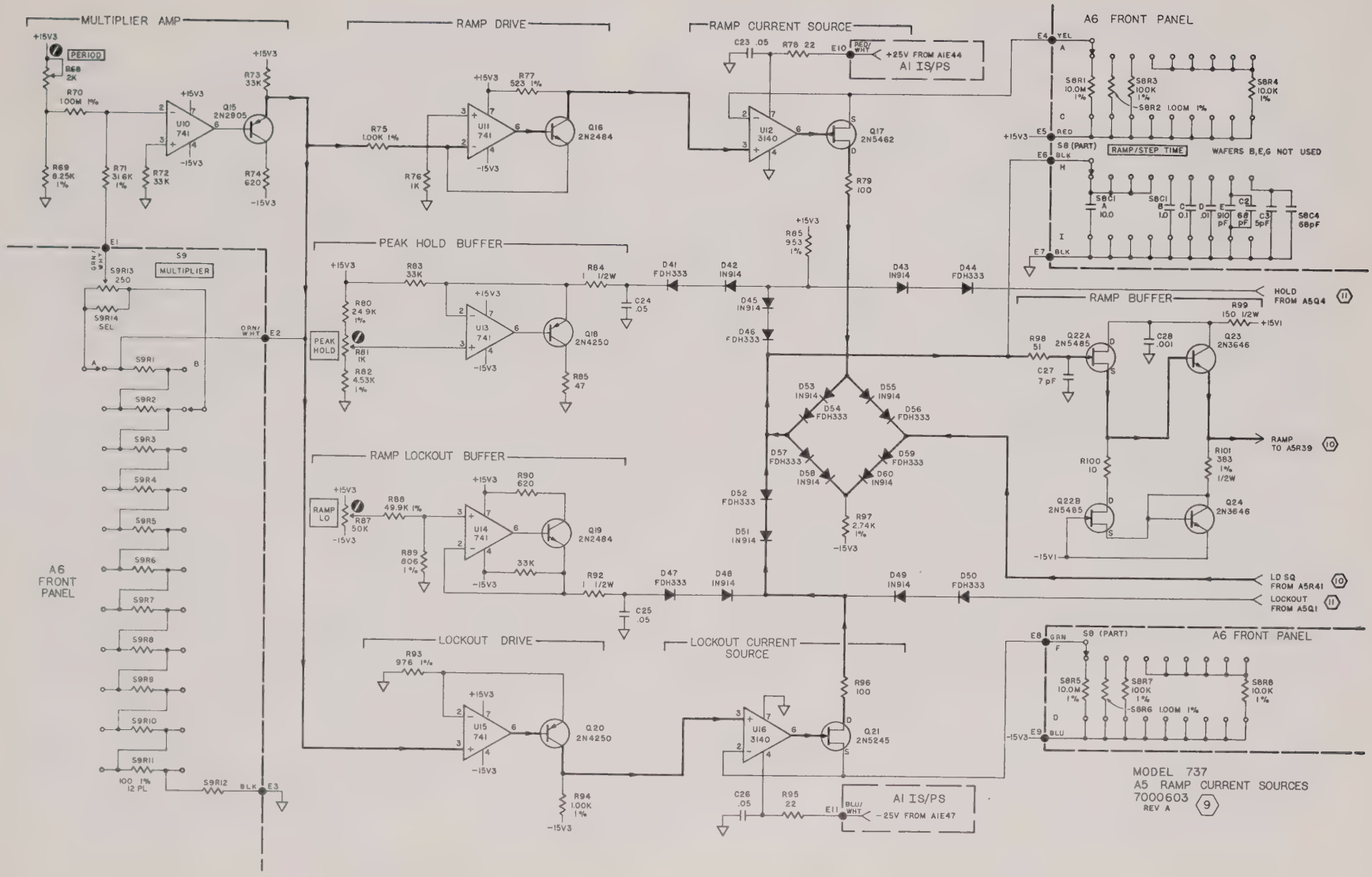
MODEL 737
A2 MAIN LOOP
7000597
REV A
4

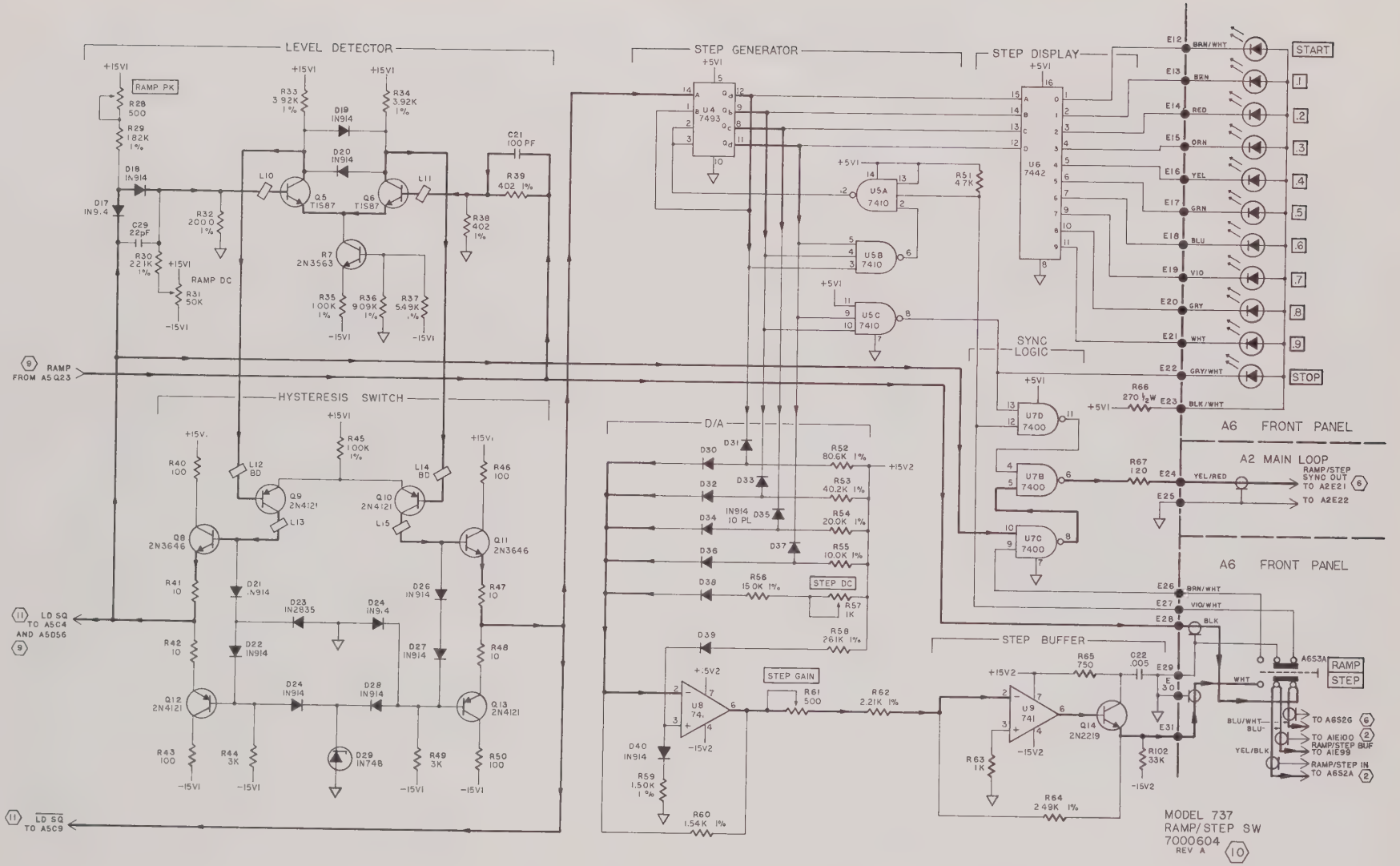

SQUARE SWITCH
A4
ATTENUATOR
A1
IS/PS
+5V FROM A1E3E
ORN
E30
+5V
+15V
+15V3
L24
2T
C44
10
C45
.001
R85
1K
R101
1K
-SQ PK
R107
500
R108
560
1/2W
L36
3T
+5V
L23
2T
C42
10
+5V1
C43
001
R81
680
U6
10105
L25
Q23
2N4258
Q24
2N4258
L26
L31
Q28
2N4258
Q29
2N4258
L32
R84
390
R87
100
R86
390
R100
390
R103
100
R102
390
YEL/WHT
AMPL TO A3E6
COM TO A3E7
R14
499
R15
499
R13
AMPLITUDE
BLK
COM TO A4E7
R37
R38
WHT
E41
E42
A6S7A
E39
E40
R90
51
R88
51
R104
51
L27
Q25
2N5179
Q26
2N5179
L28
L33
Q30
2N5179
Q31
2N5179
L34
SQ SW FROM A2R40
U1
10102
U6
10105
R89
1.5K
L29
6T
R91
1.5K
R105
1.5K
L35
6T
R106
1.5K
SINE
CONVERTER
A6S7B
R82
680
R83
680
Q27
2N2484
R95
390
R96
390
Q32
2N2484
PULSE
DC
R92
100
R94
1.5K
D30
1N914
R97
1.5K
R98
100
+SQ PK
R93
100
R99
100
R109
51
L30
2T
-15V3
-15V
C47
10
C46
001
E46
WHT
POS
E34
GRN
NEG
SQU
TRI
SINE
A6S7C
FUNCTION
A6
FRONT PANEL
E45
GRY
+5V
D27
1N914
C33
001
E14
ORN/WHT
ECL I LEVEL TO S7D
BUFFER OUT FROM A2E1
RED
E43
FROM A2E2
E44
E29
ORN/WHT
ECL I LEVEL TO S2C,D,E
MODEL 737
A2 SQUARE SWITCH
7000598
REV A

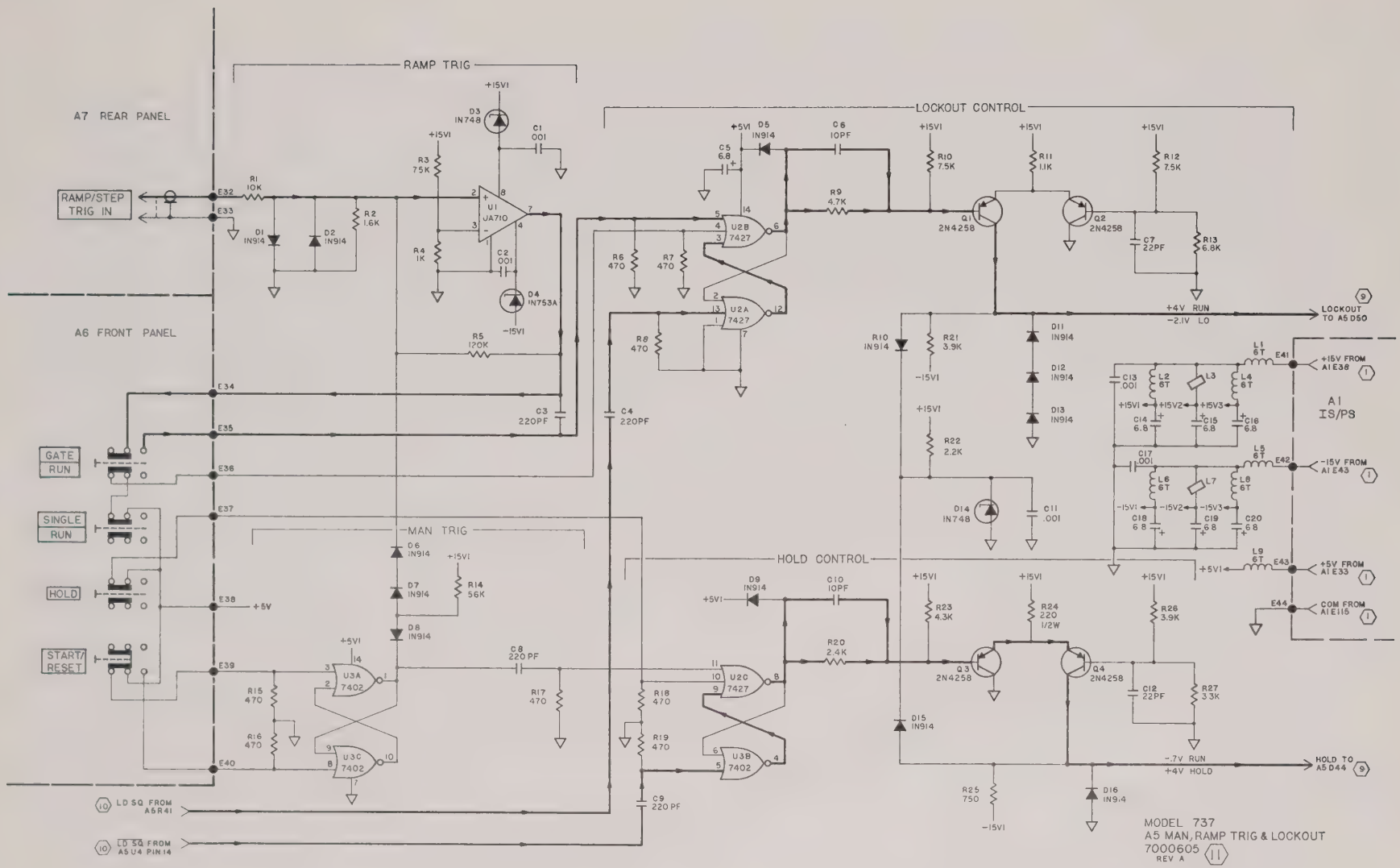

SYNC SELECTOR
SYNC DRIVER
SYNC LEVEL SHIFTER
LOCKOUT AMP
LOCKOUT LOGIC
TRIGGER
A2
A6
FRONT PANEL
A1
IS/PS
A7
REAR PANEL
SYNC LEV SHIFTER FROM A2Q1
RAMP/STEP SYNC OUT FROM A5E24
FROM A5E25
LO AMP FROM A2Q10
ECL I LEVEL FROM A6 S7C
A6S70
RAMP
SYNC
MAIN
A6S2
FREE RUN
PULSE
BURST
MAN
ECL I LEVEL FROM A2E29
RAMP STEP FROM A6S3A
INT
EXT
TRIG LEVEL
LO AMP FROM A1E39
EXT TRIG IN
TO BRIDGE OUTPUT A2R23
SQ SW TO A2U1 PIN 5
SYNC OUT
START LEVEL
MODEL 737
A2 SYNC SEL, LOCKOUT, TRIGGER
7000600
REV A


A1
IS/PS
+25V FROM A1 E44
+15V FROM A1 E36
-15V FROM A1 E40
COM FROM A1 E114
-25V FROM A1 E46
E5
E1
E2
E3
E4
+25V
+15V
-15V
COM
-25V
ATTEN
A4
AMPL POT FROM A4R13
E6
E7
1Vp-p
R1 47
R2 51
Q1
Q2
2N5179 2PL
R3 100
C 5pF
R4 510
R5 2.87K 1% 2PL
R6
R7 2K
R8 47
R9 1K
C3 3pF
R10 470
R11 500 GAIN
R12 27K
R13 20K DC LEVEL
R14 10
2Vp-p
R15 R16 680 2 PL
R17 4.7
Q3
Q4 2N4258 2PL
R18 2K
R19 100
D2 IN751 5.1V
C5 .10
C2 .005
R25 15
D1 IN758A 10V
PRE AMP
R20 1K 1/2W
R21 121 1%
R22 510
C4 8-50pF
C38 .10
C12 .10
R23 15
L2 3T
C13 6.8
-15V
.1Vp-p
SHIELD
R28 2K 1%
C11 SEL
R29 47
2N5179 2PL
Q7
Q8
R33 47
R30 51
R31 820
R32 1/2W 2PL
C37 .10
POWER AMP
+25V
+15V
L1 3T
C6 6.8
R25 15
C7 6.8
D3 IN756 8V
L3 4T
R34 160
D5 IN914
C8 .10
C9 .10
R26 R27 4.7 2PL
Q5 2N4258
Q6 2N4258
C10 .01
D4 IN4747A 20V
D6 IN4744A 15V
C14 .01
R35 27K
C15 .01
C16 .01
R36 15
R37 68
Q9 2N5583
Q10 2N5943
Q11 2N5943
R39 33
R40 33
R41 R42 51 1/2W 2PL
C20 .047
C18 .01
C19 6.8
+25V1
C21 .047
R58 240
L4 3T
C17 6.8
D7 IN914
R38 10
R43 R44 10 2PL
R55 100 2W
C22 5.5-18pF
R56 10
R57 100 2W
30Vp-p
D8 IN914
Q12 2N5943
Q13 2N5583
Q14 2N5583
R48 33
R49 33
R53 R54 10 2PL
R45 160
R46 68
L5 3T
C23 .01
C25 .047
C24 .01
R50 R51 51 1/2W 2PL
C27 6.8
C26 .047
-25V1
D9 IN914
R47 15
R52 240
L6 3T
C28 68
-25V
ATTEN
A4
15Vp-p INTO 50 Ω
E8
E9
BLK
PA OUT TO A4E1
COM A4E2
MODEL 737
A3 PA, PRE AMP
7000601
REV A
7


OFFSET DRIVER
A3
PA/PRE AMP
FRONT PANEL
A6
REAR PANEL
A7
ATTENUATOR
A4
+25V
+25V3
+25V2
-25V3
-25V2
-25V
-5V
+15V
OUTPUT
50Ω
DC
OFFSET
GAIN
R3
10K
S4
L1
3K
6T
140050
L7
6T
L8
2T
L9
2T
L10
2T
L11
2T
R60
5.11K
1%
R62
5.11K
1%
R63
3.9K
R64
100
R65
150
½W
R66
150
½W
R67
150
½W
R68
680
R69
1.2K
R59
10.0K
1%
R61
10.7K
1%
R70
10.0K
1%
R71
5.11K
1%
R72
10.7K
1%
R73
5.11K
1%
R74
100
R75
3.9K
R76
150
½W
R77
150
½W
R78
150
½W
R79
680
C30
.005
C31
6.8
C32
.001
C33
6.8
C34
6.8
C35
.001
C36
6.8
D10
IN914
D11
IN758A
D12
IN914
D13
IN758A
U1
741
U2
741
Q15
2N4250
Q16
2N2484
Q3
2N4918
Q4
2N4921
30dB
ATTENUATOR
10dB
R3
34.8
1%
R4
18
22pf
PA OUT
FROM A3E8
COM
FROM A3E9
E1
E2
E3
E4
E5
E10
E11
E12
E13
E14
E7
BLK WHT
YEL
BLK
MODEL 737
A3 OFFSET DRIVER
A4 ATTENUATOR
7000602
REV A
8


MULTIPLIER AMP
RAMP DRIVE
RAMP CURRENT SOURCE
A6 FRONT PANEL
PERIOD
R68 2K
R70 100M 1%
R69 8.25K 1%
R71 31.6K 1%
R72 33K
R73 33K
R74 620
U10 741
Q15 2N2905
+15V3
-15V3
R75 100K 1%
R76 1K
R77 523 1%
U11 741
Q16 2N2484
C23 .05
R78 22
E10 RED/WHT
+25V FROM AIE44
AI IS/PS
U12 3140
Q17 2N5462
R79 100
S8R1 10.0M 1%
S8R3 100K 1%
S8R2 100M 1%
S8R4 10.0K 1%
S8 (PART)
RAMP/STEP TIME
WAFERS B,E,G NOT USED
S8C1 A 10.0
S8C1 B 1.0
S8C1 C 0.1
S8C1 D .01
S8C1 E 910 pF
C2 68 pF
C3 5pF
S8C4 68pF
E1
GRN/WHT
S9
MULTIPLIER
S9R13 250
S9R14 SEL
S9R1
S9R2
S9R3
S9R4
S9R5
S9R6
S9R7
S9R8
S9R9
S9R10
S9R11
100 1% 12 PL
S9R12
BLK
E3
ORN/WHT
E2
A6 FRONT PANEL
PEAK HOLD BUFFER
R83 33K
R84 1 1/2W
R80 24.9K 1%
R81 1K
R82 4.53K 1%
PEAK HOLD
U13 741
Q18 2N4250
R85 47
C24 .05
D41 FDH333
D42 IN914
D43 IN914
D44 FDH333
D45 IN914
D46 FDH333
R65 953 1%
RAMP BUFFER
HOLD FROM A5Q4
R99 150 1/2W
+15V1
R98 51
Q22A 2N5485
C28 .001
Q23 2N3646
C27 7 pF
D53 IN914
D54 FDH333
D55 IN914
D56 FDH333
D57 FDH333
D58 IN914
D59 FDH333
D60 IN914
R97 2.74K 1%
RAMP TO A5R39
R100 10
R101 383 1% 1/2W
Q22B 2N5485
Q24 2N3646
-15V1
D52 FDH333
D51 IN914
LD SQ FROM A5R41
LOCKOUT FROM A5Q1
RAMP LOCKOUT BUFFER
RAMP LO
R87 50K
R88 49.9K 1%
R89 806 1%
U14 741
Q19 2N2484
R90 620
33K
R92 1 1/2W
C25 .05
D47 FDH333
D48 IN914
D49 IN914
D50 FDH333
LOCKOUT DRIVE
R93 976 1%
U15 741
Q20 2N4250
R94 1.00K 1%
LOCKOUT CURRENT SOURCE
R96 100
U16 3140
Q21 2N5245
C26 .05
R95 22
E11 BLU/WHT
AI IS/PS
-25V FROM AIE47
S8 (PART)
A6 FRONT PANEL
S8R5 10.0M 1%
S8R7 100K 1%
S8R6 100M 1%
S8R8 10.0K 1%
MODEL 737
A5 RAMP CURRENT SOURCES
7000603
REV A
9


LEVEL DETECTOR
STEP GENERATOR
STEP DISPLAY
HYSTERESIS SWITCH
D/A
SYNC LOGIC
STEP BUFFER
A6 FRONT PANEL
A2 MAIN LOOP
A6 FRONT PANEL
START
STOP
RAMP PK
RAMP DC
STEP DC
STEP GAIN
RAMP FROM A5Q23
LD SQ TO A5C4 AND A5D56
LD SQ TO A5C9
RAMP/STEP SYNC OUT TO A2E21
TO A2E22
RAMP STEP
MODEL 737
RAMP/STEP SW
7000604
REV A


A7 REAR PANEL
A6 FRONT PANEL
RAMP TRIG
RAMP/STEP TRIG IN
GATE RUN
SINGLE RUN
HOLD
START/ RESET
MAN TRIG
LOCKOUT CONTROL
HOLD CONTROL
+15V1
-15V1
+5V1
+5V
+4V RUN
-2.1V LO
LOCKOUT TO A5 D50
-.7V RUN
+4V HOLD
HOLD TO A5 D44
+15V FROM A1 E38
-15V FROM A1 E43
+5V FROM A1 E33
COM FROM A1 E115
A1 IS/PS
LD SQ FROM A5 R41
LD SQ FROM A5 U4 PIN 14
MODEL 737
A5 MAN, RAMP TRIG & LOCKOUT
7000605
REV A

SECTION 8

ADDENDA

MODEL 737